Wave Forces on a Horizontal Circular Cylinder Near a Plane Boundary

by

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A THESIS

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Wave force measurements were taken on a horizontal 30.48cm (12.0") diameter circular cylinder at the Oregon State University Wave Research Facility to determine the influence of a plane boundary on these forces. The longitudinal axis of the cylinder was oriented perpendicular to the incident gravity wave flow. H/T^2 ranged from 0.0085 to 0.505 ft/sec^2. h/T^2 ranged from 0.078 to 2.57 ft/sec^2. Maximum values of Reynolds numbers ranged from 2.0×10^3 to 2.0×10^5. Force coefficients of inertia, lift and drag for a horizontal circular cylinder varied according to the proximity of a plane boundary, expressed as e/D, and the relative horizontal displacement of the water particles, expressed as A/D. Values of C_I increased from $C_I = 1.9$ to $C_I = 3.5$ as the cylinder approached the plane boundary. Agreement with theoretical values for a uniformly accelerated flow was good. For $A/D < 1.5$ and $e/D > 0$, values of C_L varied from $C_L = 0$ to $C_L = -5.3$ as the cylinder approached the plane boundary.

Agreement with potential flow theory was good. For $1.5 < A/D < 5.0$ and $e/D = 0$, $C_L = 1.9$. For $1.5 < A/D < 5.7$ and $e/D > 0$, C_L increased from $C_L = 0$ to $C_L = 2.6$ as the cylinder approached the plane boundary. For $1.5 < A/D < 5.7$ and $0 < e/D < 1.0$, large alternating positive and negative lift forces occurred at twice the wave frequency. As the cylinder approached the plane boundary for $Re \cong 1.3 \times 10^5$, C_D increased from $C_D = 0.66$ at $e/D = 1.0$ to $C_D = 1.9$ at $e/D = 0.17$, and then decreased to $C_D = 0.93$ at $e/D = 0$. The possibility of a phase difference between the ambient velocity at the cylinder and the drag force was shown. Variations in water depth produced variations in C_I and C_L. As h/D varied from $h/D = 2.35$ to $h/D = 7.8$, C_I evaluted from vertical forces increased from $C_I = 1.8$ to $C_I = 3.08$ and C_I evaluated from horizontal forces increased from $C_I = 2.8$ to $C_I = 3.05$. For $A/D < 1.5$, as h/D varied from $h/D = 2.35$ to $h/D = 7.8$, C_L varied from $C_L = -4.29$ to $C_L = -5.26$. For $A/D > 1.5$, water depth had no apparent effect on C_L or C_D. The advantages of using the Stream function wave theory in lieu of the Airy wave theory were demonstrated.

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NOMENCLATURE

A/D = Ratio of maximum horizontal particle displacement to cylinder diameter

C_A = Inertia coefficient for convective acceleration

C_D = Drag coefficient

C_H = Horizontal calibration constant

C_I = Inertia coefficient for temporal acceleration

C_L = Lift coefficient

C_M = Added mass coefficient

D = Cylinder diameter

e/D = Ratio of distance between plane boundary and cylinder to cylinder diameter

ε = Strain

$f(\theta)$ = Phase shift factor

f_v = Natural vertical frequency of vibration

f_s = Frequency of vortex shedding

$\pm F_H$ = Horizontal force per unit length of cylinder

$\pm F_V$ = Vertical force per unit length of cylinder

F_M = Maximum force range ratio

F_{HA} = Horizontal acceleration force per unit length of cylinder

F_{HD} = Horizontal drag force per unit length of cylinder

F_L = Lift force per unit length of cylinder

h = Water depth

H = Wave height

H_B = Breaking wave height

L = Wave length

T = Wave period

U_m = Maximum horizontal velocity

U = Horizontal velocity

V = Vertical velocity

$\mathring{U}$ = Temporal horizontal acceleration

$\mathring{V}$ = Temporal vertical acceleration

Γ = Circulation

η = Instantaneous surface elevation of wave measured from still water level

ϕ = Velocity potential

ρ = Mass density of fluid

μ = Fluid viscosity

WAVE FORCES ON A HORIZONTAL CIRCULAR CYLINDER NEAR A PLANE BOUNDARY

I. INTRODUCTION

In recent years engineering design of ocean structures has become more highly developed due to the increased demand for ocean resources and offshore storage and living facilities. Much research is being conducted to better understand the dynamics of the ocean, the fluid flow around structures placed in the ocean, and the response of the structures to the ocean waves and currents.

To establish a useful foundation for the design of ocean structures, at least two areas of research are important. First, research can be conducted in the field to develop an analytical or numerical model which will predict the ocean kinematics and dynamics. The theoretical results can be correlated with measured forces on a prototype structure. Second, research can be conducted in the laboratory to correlate the known or well-controlled flow characteristics with measured forces on a model. The experimentation and conclusions contained herein reflect a laboratory model study conducted at the Oregon State University Wave Research Facility through the National Oceanic and Atmospheric Administration under Sea Grant Contract 04-5-158-2. The forces on a horizontal circular cylinder near a plane boundary due to gravity waves were specifically considered in this

investigation since circular cylinders are commonly used in ocean structures and can also represent pipeline networks between these structures and shore.

The study of hydrodynamic forces on cylinders can be classified into at least four major flow regimes: (1) steady flow at subcritical Reynolds numbers; (2) steady flow at supercritical Reynolds numbers; (3) unsteady flow at subcritical Reynolds numbers; and (4) unsteady flow at supercritical Reynolds numbers. Understandably, experimental results have been most abundant for the steady flow regions. Most laboratory modeling has produced few results at supercritical Reynolds numbers.

Analysts have endeavored to correlate the hydrodynamic forces on cylinders in unsteady flow to the kinematics of the flow field. The most widely used approach has been the Morison equation which represents the total force on a structure as the linear sum of an inertia and drag force. These component forces are related to the flow kinematics through certain dimensionless force coefficients which may be determined analytically or experimentally.

The purpose of this thesis is to report on the results of research into the effect of a plane boundary on the hydrodynamic forces on a horizontal circular cylinder whose longitudinal axis is oriented perpendicular to incident gravity wave flow. The following topics are specifically examined:

1. The contribution of potential flow effects and wake effects on the magnitude and direction of the hydrodynamic forces;
2. The relation between the force coefficients of inertia and lift and the proximity of the cylinder to a plane boundary;
3. The relation between the coefficient of drag and the proximity of the cylinder to a plane boundary; and
4. The effect of variations in water depth on the force coefficients of inertia, lift, and drag.

II. REVIEW

Past theoretical and experimental investigations of both steady and unsteady flow around cylinders will be briefly reviewed. This review will facilitate the description of the mechanics of unsteady flow across a horizontal cylinder and of the resulting hydrodynamic forces on the cylinder.

Wave Force Analysis

Wave forces on submerged cylinders may be estimated by analytical methods or empirical methods. Closed solutions of a mathematical model resulting from analytical methods are infrequently obtained. These solutions arise from some form of the Navier-Stokes equations when viscous effects are considered or from the Euler equation when viscous effects are ignored. Empirical methods of force analysis are used more frequently however since the oscillatory flow around a cylinder can be a complex combination of potential flow characteristics and the real flow characteristics of free stream turbulence and wake formation. The most extensively used empirical method has been the so-called Morison equation.

Morison, O'Brien, Johnson and Schaaf (8) conducted initial research specifically related to wave forces on vertical piling. Their approach represents the total force on a structure as a linear sum of drag and inertia terms. These

terms are in turn related to the kinematic flow field and certain hydrodynamic force coefficients. The Morison equation shows the total horizontal force per unit length on a cylinder to be

$$F_H = C_I \rho \frac{\pi D^2}{4} \frac{\partial U}{\partial t} + C_D \rho D \frac{U|U|}{2} \tag{1}$$

where

$$C_I = \frac{F_{HD}}{\rho \frac{\pi D^2}{4} \frac{\partial U}{\partial t}} \tag{2}$$

$$C_D = \frac{F_{HD}}{\rho D \frac{U|U|}{2}} \tag{3}$$

The coefficients of inertia and drag are in most cases experimentally determined. However, the inertia coefficient may be analytically determined from potential flow theory.

The above force coefficients have been computed by correlating measured forces with theoretical kinematics as investigated by Dean and Aagaard (3) using the Stream function wave theory or by correlating measured forces with measured kinematics as investigated by Keulegan and Carpenter (7) and more recently, Sarpkaya (11).

In order to establish design values of the hydrodynamic force coefficients, investigators have sought to find some dependence of these coefficients on certain flow parameters. For example, for a cylinder in an infinite fluid in steady flow, four such parameters are the Reynolds number, cylinder

roughness, free stream turbulence, and boundary conditions. They alter the flow configuration and hence the drag coefficient. The Reynolds number is a similarity parameter which expresses the ratio of inertia forces to viscous forces as

$$Re = \frac{\rho U D}{\mu} .$$

A distinct dependence of C_D and the Reynolds number has been found for a cylinder in an infinite fluid in steady flow. Roshko (9) shows that Figure 1 can be divided into five regions:

1. Subcritical where $C_D = 1.2$ for $10^4 < Re < 2 \times 10^5$;
2. Lower transition ($2 \times 10^5 < Re < 10^6$);
3. Supercritical ($5 \times 10^5 < Re < 10^6$) where $C_D \cong 0.3$;
4. Upper transition ($10^6 < Re < 3.5 \times 10^6$); and
5. Transcritical ($Re > 3.5 \times 10^6$) where $C_D = 0.7$.

In the presence of a plane boundary or when a cylinder is immersed in a boundary layer, the coefficient of drag is altered. For $0.1 \le e/D \le 1.7$, as defined in Figure 2, Wilson and Caldwell (14) found that C_D varied from 1.7 to 1.8 with $Re = 3.3 \times 10^4$ and from 1.1 to 1.25 with $Re = 5.66 \times 10^4$. For a cylinder resting on the bottom, Beattie, Brown and Webb (1) show an approximate value of $C_D = 0.4$ for Reynolds numbers greater than 0.5×10^6.

Wilson *et al*. (14) also show that the coefficient of lift varies with the presence of a plane boundary in steady flow where the coefficient of lift is defined as

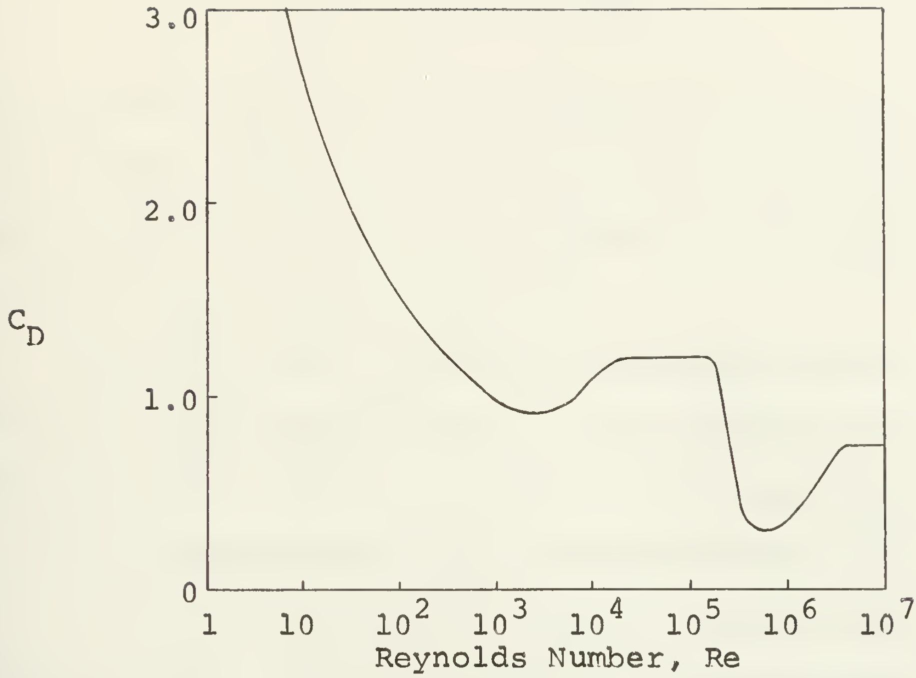


Figure 1. Drag coefficient for circular cylinder as a function of Reynolds number (from Ref. 9).

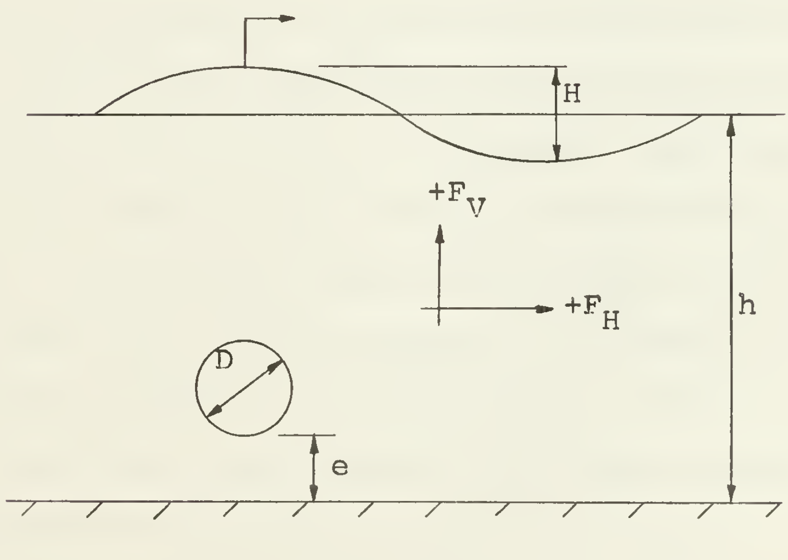


Figure 2. Cylinder cross-section close to plane boundary.

$$C_L = \frac{F_L}{\frac{1}{2}\rho D U^2} \tag{4}$$

For Re = 3.3×10^4, $C_L = 0.57$ at e/D = 0.02 and $C_L = 0.33$ at e/D = 0.25. For Re = 5.66×10^4, $C_L = 0.28$ at e/D = 0.02 and $C_L = 0.17$ at e/D = 0.25. Rouse (10) shows that for Re = 1.5×10^5, $C_L = 0.50$ at e/D = 0.

Therefore, for a stationary cylinder placed in steady flow, the force coefficients of drag and lift vary with the Reynolds number and the proximity of a plane boundary. In a uniformly accelerated flow, the coefficient of inertia for a cylinder is also a function of the proximity of a plane boundary. It is a function of the Reynolds number only when a wake forms. The wake alters the effective shape of the cylinder which in turn alters the coefficient of inertia.

Within the unsteady flow associated with the passage of a wave, the cylinder experiences effects from potential flow conditions and real flow conditions. For potential flow, the flow field is accelerating and irrotational except in the thin boundary layer at the surface of the cylinder. For real flow, the development of a uniform wake or an alternating wake due to vortex shedding alters the flow field from potential flow. Force coefficients determined under unsteady flow conditions therefore, respond to either potential flow effects or wake effects. And as with steady flow, it is equally important to determine whether these

force coefficients vary with the Reynolds number, the proximity of a plane boundary, or other flow parameters such as $\frac{U_m T}{D}$ discussed below. Thus, conditions may occur where C_D is dependent on wake effects and C_I and C_L are dependent on both wake and potential flow effects. Since the presence of a plane boundary alters both the characteristics of a wake and the potential flow field, then conditions may also occur where these force coefficients are dependent on the location of the plane boundary.

Using measured forces on vertical piling from a field project correlated with the theoretical kinematics provided by the Stream function wave theory, Dean et al. (3) showed that within the range where their drag coefficient analysis was well-conditioned ($Re > 6.0 \times 10^5$), C_D decreased with increasing Reynolds numbers. For $Re < 3 \times 10^5$, they found that the steady state value of $C_D = 1.2$ from Roshko (9) was consistent with data analysis results. Values of C_I were shown to be constant at $C_I \simeq 1.5$ for all Reynolds numbers where the inertia coefficient analysis was well-conditioned.

In a laboratory project using measured forces on horizontal submerged cylinders, in an infinite fluid, correlated with measured kinematics, Keulegan et al. (7) found that C_D and C_I depended on a period parameter defined as $\frac{U_m T}{D}$, where U_m is the maximum horizontal velocity. This parameter emphasizes the relationship of the force coefficients to the amplitude of the particle displacement and is related

to the ratio of the displacement to cylinder diameter according to Airy wave theory by

$$A/D = \frac{1}{2\pi}\frac{U_mT}{D} \ . \qquad (5)$$

They found that with a given cylinder diameter, C_I varies as the maximum current, U_m, is varied. A similar variation occurred for C_D. A correlation between these coefficients and the Reynolds number as found by Dean <u>et al</u>. (3) did not appear to exist. In this regard, Thirriot, Longree, and Barthet (13) found that when $A/D > 10$ the C_D for steady flow was approximately equal to the C_D for oscillatory flows for a vertical cylinder. Also for $1 \leq A/D \leq 10$, the C_D for oscillatory flow was larger than the C_D for steady flow. This variation was valid for $Re \leq 4 \times 10^4$. For larger Reynolds numbers the value of C_D for oscillatory flow equalled the C_D for steady flow regardless of the particle displacement.

Specifically, Keulegan <u>et al</u>. (7) showed that $C_D = 0.9$ for $\frac{U_mT}{D} < 5$ $(A/D < 0.8)$ and increased to $C_D = 2.5$ at $\frac{U_mT}{D} = 15$ $(A/D = 2.4)$. For greater values of the period parameter there was a gradual decrease in the drag coefficient to the steady state value found by Roshko (9). They found that $C_I = 2.0$ for $\frac{U_mT}{D} < 6$ $(A/D < 1.0)$, as expected from potential flow theory. For $\frac{U_mT}{D} > 37$ $(A/D > 6)$, $C_I = 1.5 - 2.5$.

Yamamoto, Nath, and Slotta (15) investigated the dependence of both C_I and C_L on the relative distance of a

horizontal cylinder from a plane boundary. For potential flow, where $A/D < 1.0$, they found that $C_I = 4.15$ at $e/D = 0.02$ compared with $C_I = 2.0$ for a cylinder in an infinite fluid. They also reported that C_L increases to large negative values as the cylinder is placed nearer a plane boundary for potential flow. They showed $C_L = -8.45$ for $e/D = 0.02$. In addition, they emphasized the need for further experimentation to determine the effect of variations in water depth on force coefficients, although they could not determine the effect because of limited experimental data.

The experimental results discussed above show that the force coefficients for a circular cylinder do indeed depend on at least four factors: the Reynolds number, the Keulegan-Carpenter period parameter, the proximity of a plane boundary, and variations in water depth. Values of these coefficients must therefore be chosen carefully when used in the Morison equation.

Limitations of the Morison Equation

The Morison equation is limited in application and does not provide realistic values of forces in the following cases. First, the forces predicted by this equation are necessarily dependent on a theoretical wave theory if flow kinematics cannot be actually measured. In this regard some of the differences between two widely used wave theories will be explored in the next section. Second, according to

Ippen (6), the force on a cylinder in a wave pressure field as found by the Morison equation will not take into account the mean pressure surrounding the cylinder. Thus, the cylinder must be additionally designed to withstand the expected hydrostatic pressure. Third, the assumption of constant values of drag and inertia coefficients throughout the water depth and wavelength is consistent for cases where the flow kinematics are actually measured. Here the force coefficients are dependent on Keulegan-Carpenter parameter. However for cases where theoretical kinematics are used, the drag coefficient varies with the Reynolds number while the inertia coefficient remains constant. Fourth, as discussed by Yamamoto et al. (15), the proximity of a plane boundary to the cylinder alters these force coefficients greatly. For example, according to potential flow theory, the small gap between a cylinder and the bottom boundary can produce large vertical forces toward the boundary, an effect which decreases as the cylinder is moved from the boundary. Likewise, the coefficients are affected by the proximity of a free surface. They also indicated that there may exist a phase shift between the ambient velocity and the drag force. Thus, the coefficient of inertia evaluated under the assumption of a zero drag force may be in error due to this phase shift possibility. Fifth, for a cylinder resting on the bottom, the Morison equation predicts no vertical forces; whereas due to the asymmetry of the flow, a net positive

vertical force occurs. Sixth, the force coefficients may be influenced by the water depth. And finally seventh, the Morison equation predicts no transverse forces due to vortex shedding or periodic wake phenomena.

Comparison Between Airy Wave Theory and Stream Function Wave Theory

In order to use an equation such as the Morison equation for design purposes, values for the force coefficients and the fluid kinematics surrounding the structure must be obtained. The force coefficients are obtained experimentally either using a laboratory model or a field prototype. The experimentally measured forces are correlated with either measured or theoretical values of the fluid velocities and accelerations. However, in general practice, fluid kinematics surrounding the structure are not known *a priori*. Generally only surface fluctuations have been recorded. Therefore, the use of a wave theory which will predict accurate values of the fluid kinematics is necessary to determine satisfactory values of the force coefficients.

Although there are numerous wave theories available to the analyst, a comparison will be made between the first order Airy wave theory and the Stream function wave theory established by Dean (2). This brief comparison will emphasize the differences in predicted surface profiles and kinematics for both theories in order that these differences may

later explain some of the scatter found in force coefficient determinations in this investigation.

In review, the Airy wave theory, used throughout this investigation to determine fluid kinematics, is the classical hydrodynamic solution to the irrotational and incompressible progressive wave. It is the first order solution to the Laplace equation with boundary conditions evaluated at the still water level, where the Laplace equation for two dimensional flow is

$$\nabla^2\phi = 0 \text{ and } \nabla = \vec{i}\,\frac{\partial}{\partial x} + \vec{j}\,\frac{\partial}{\partial y}$$

According to the perturbation method of solution, higher order solutions to the Laplace equation will more nearly satisfy the free surface boundary condition. The Stream function theory is applicable to waves of steepness up to breaking. It also satisfies the two dimensional Laplace equation and assumes the wave flow does not change with respect to time for cases based on measured wave profiles. It is formulated by a nonlinear numerical perturbation procedure which reduces the error in the dynamic free surface boundary condition to acceptable levels. Since it satisfies the kinematic free surface boundary condition exactly due to the steady state assumption, it provides a significantly better fit to these boundary conditions for shallow and deep water waves than most analytical theories. Currently the Stream function theory has been evaluated for 40 different

waves varying from shallow to deep water conditions and from $H/H_B = 0.25$ to $H/H_B = 1.00$, where H_B is the breaking wave height.

In representing surface profiles of various waves, the Stream function generally predicts higher peak wave amplitudes and a more shallow trough than the symmetric prediction by Airy theory. Figure 3 shows the dimensionless surface profile according to the Stream function plotted against wave phase for the case where $H/H_B = 0.75$, $H/T^2 = 0.118$ ft/sec^2, and $h/T^2 = 0.20$ ft/sec^2. Figure 4 again shows the dimensionless surface profile predicted by the Stream function compared to the experimental run 723 and the profile predicted by Airy theory. From these figures one would expect that some of the actual kinematics of flow during the passage of a wave would be poorly predicted by Airy wave theory. However, a notable exception to this was pointed out by Grace and Rocheleau (5) and Dean and LeMéhauté (4). They indicate that Airy wave theory predicts the horizontal velocities of the flow exceptionally well near the bottom boundary beneath the wave crest.

Figure 5 compares values of dimensionless horizontal velocity and acceleration and vertical acceleration for both wave theories. Since the cylinder is far from the free surface, the presence of the cylinder does not affect the flow field. Therefore these particle kinematics represent those which the cylinder experiences at $e/D = 0.042$. The maximum

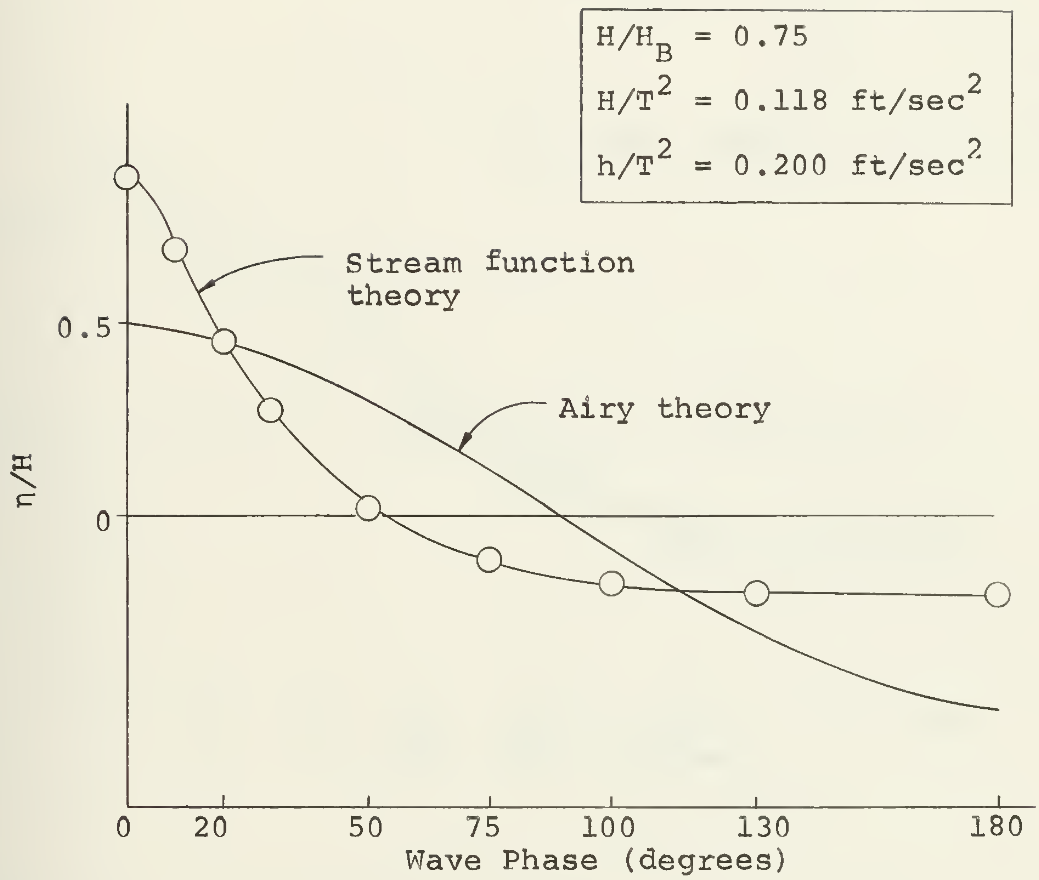


Figure 3. Dimensionless surface profile comparison for Airy theory and Stream function theory.

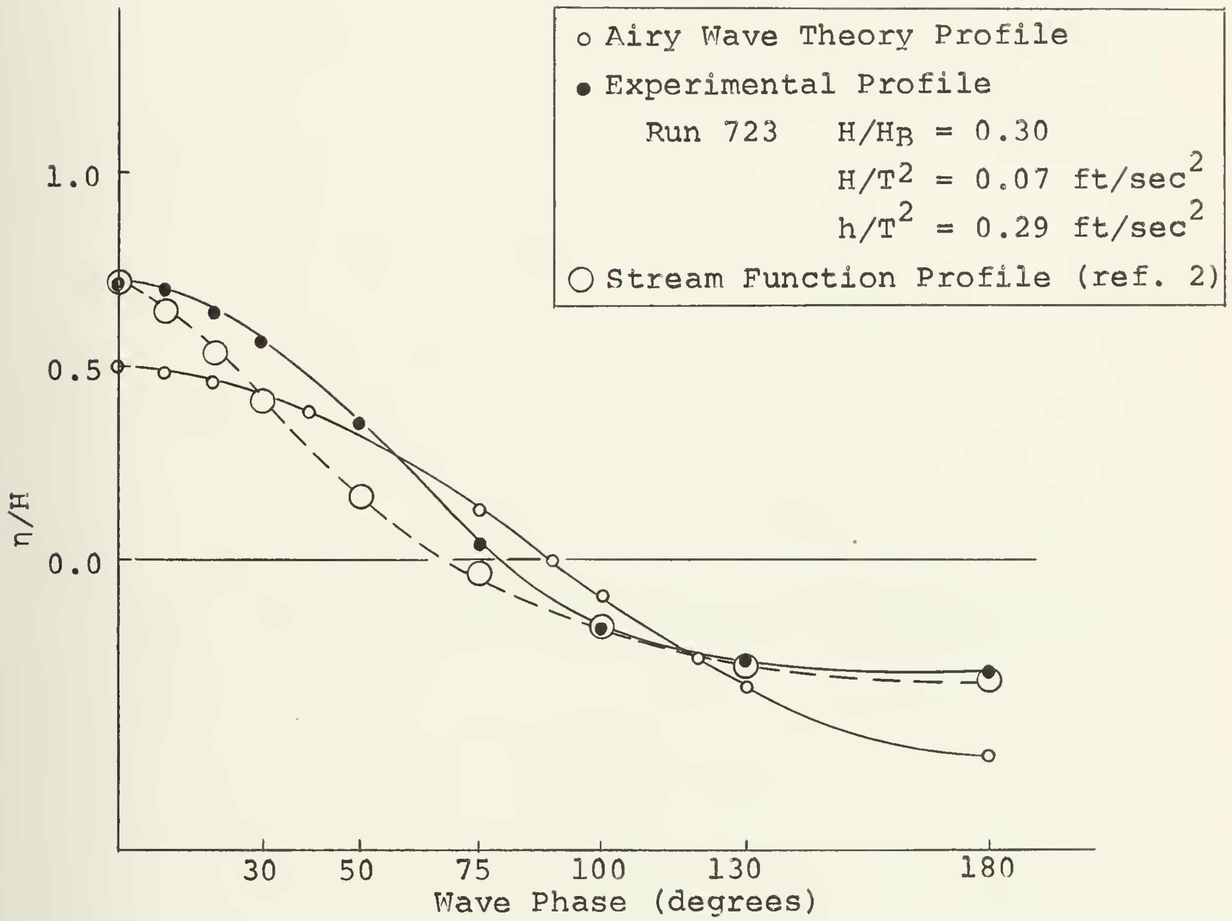


Figure 4. Dimensionless surface profile comparison for Run 723 and profile predicted by Stream function.

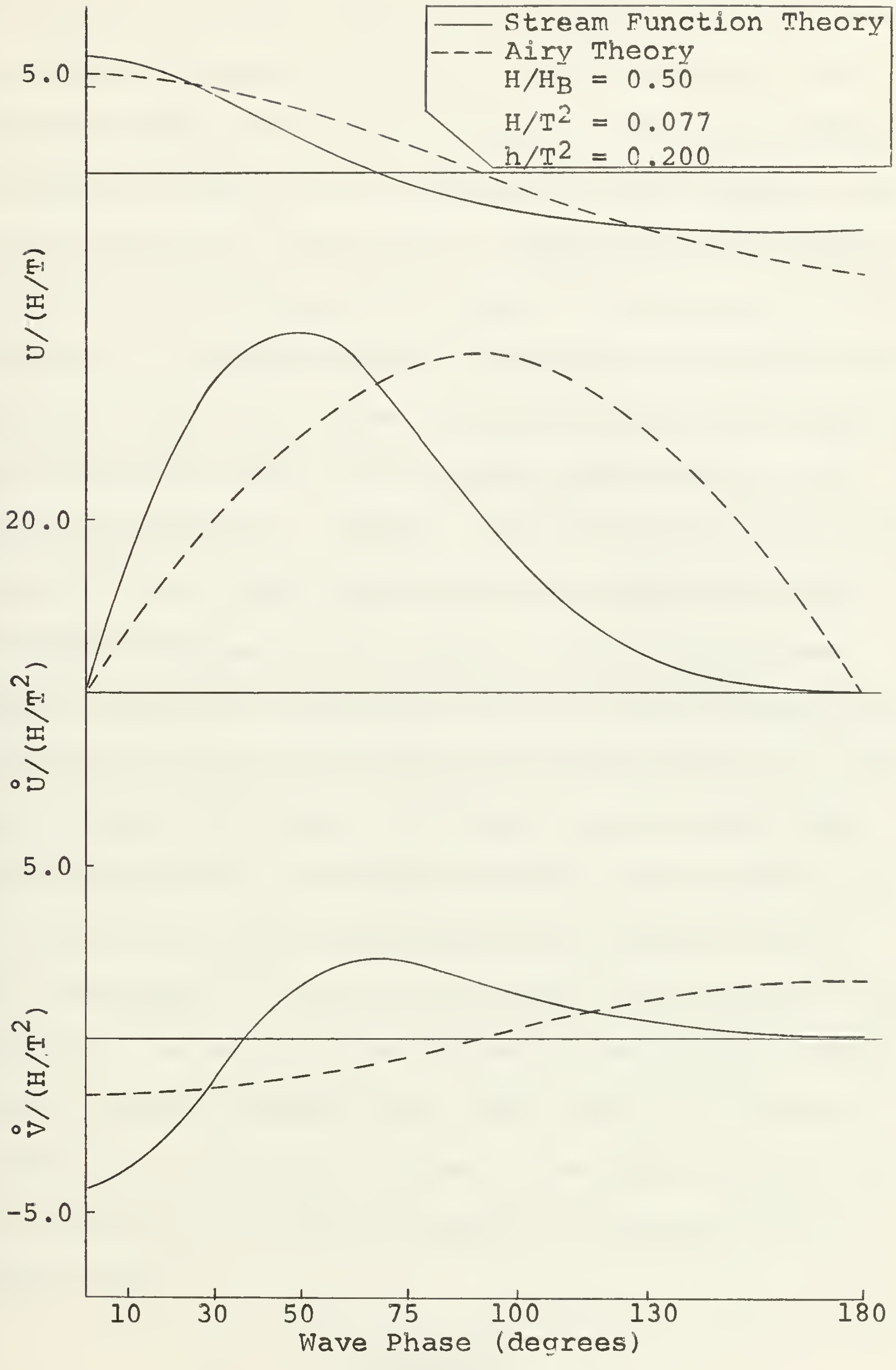


Figure 5. Kinematic comparison for Airy theory and Stream function theory for cylinder at e/D = 0.042.

value of the horizontal velocity and acceleration are nearly equal in both theories. In fact, for this example, the maximum horizontal velocity according to the Stream function is 16 percent greater than predicted by Airy theory. Likewise, the horizontal acceleration according to the Stream function is only eight percent greater than predicted by Airy theory. A portion of this difference in acceleration is justified since the Stream function theory evaluates the total acceleration while Airy theory evaluates only the temporal acceleration. However, the horizontal acceleration predicted by the Stream function shows a definite phase shift toward the crest of the wave. The dimensionless vertical acceleration predicted by the Stream function exhibits a large difference from that predicted by Airy wave theory at most wave phases. In fact, at the crest, the vertical acceleration according to the Stream function is over 160 percent greater than predicted values of Airy theory! Therefore, it may be concluded that maximum values of horizontal velocity and acceleration determined by Airy theory are fairly accurate under the crest of a wave and near the bottom. However, values of vertical acceleration may be seriously in error throughout the water depth for nonlinear waves.

Conclusion

The Morison equation not only fails in the prediction of certain forces on cylinders placed within one cylinder

diameter of a plane boundary but when the flow kinematics are theoretically determined, the force coefficients within that equation may vary throughout the wave. These coefficients depend on the Keulegan-Carpenter period parameter for measured kinematics and on the Reynolds number for theoretical kinematics provided by the Stream function. Therefore, it was the general purpose of the research reported herein to investigate the effects of a plane boundary and water depth on the forces on a horizontal circular cylinder in oscillatory flow for as wide a range of Reynolds numbers and values of A/D as possible.

Utilizing several results from Yamamoto et al. (15), a model is presented here which includes the basic approach of the Morison equation but also includes additional factors which must be considered in the evaluation of forces on horizontal cylinders. This model will be used later to summarize some experimental results. For uniform flow, the horizontal and vertical forces can be considered as

$$F_H = C_I \frac{\rho\pi D^2}{4} \frac{\partial U}{\partial t} + C_A \frac{\rho\pi D^2}{4} [U \frac{\partial U}{\partial x} + V \frac{\partial U}{\partial y}] + C_D \rho D \frac{U|U|}{2} f(\theta) \tag{6}$$

$$F_V = C_I \frac{\rho\pi D^2}{4} \frac{\partial V}{\partial t} + C_A \frac{\rho\pi D^2}{4} [U \frac{\partial V}{\partial x} + V \frac{\partial V}{\partial y}] + C_D \rho D \frac{V|V|}{2} f(\theta) + C_L \rho D \frac{U^2}{2} + \rho\Gamma U. \tag{7}$$

where C_I = Inertia coefficient. For a uniform flow,

$$C_I = (1.0 + C_M).$$

C_M is an added mass coefficient which for a cylinder uniformly accelerated in a fluid at rest, is equal to the ratio of the hydrodynamic force necessary to maintain the motion of the cylinder in the presence of the fluid to the displaced mass of the fluid by the cylinder. In an infinite fluid, $C_M = 1.0$ according to potential flow theory. For the case of a stationary cylinder in a uniformly accelerating flow, a coefficient due to the pressure field causing acceleration of the fluid is added to the added mass coefficient to yield the inertia coefficient. This pressure coefficient is always equal to 1.0 for any submerged object in a uniform flow. It is noted here that for a uniform flow, variations in e/D will produce variations in C_I by varying C_M. For a nonuniform flow the pressure coefficient no longer equals 1.0, nor does C_M remain defined as before. Thus, variations in C_I result from variations in e/D and flow nonuniformity.

C_A = Inertia coefficient for convective acceleration which is defined similarly to the inertia

coefficient for local acceleration. From potential flow theory, $C_A = 2.0$ and this value is constant for all values of e/D. It is noted here that values of C_I determined by Dean _et al._ (3) using the Stream function wave theory were based on total fluid acceleration including the convective contribution.

$f(\theta)$ = Phase shift factor between ambient flow and the drag force which is to be experimentally determined.

Γ = Induced circulation around the cylinder due to vortex formation which is combined with the uniform velocity in the well-known Kutta-Joukowski relation.

The horizontal convective acceleration of the ambient flow

$$U \frac{\partial U}{\partial x} + V \frac{\partial U}{\partial y}$$

is constant throughout the water depth according to Airy wave theory and varies at twice the wave frequency. The vertical convective acceleration of the ambient flow

$$U \frac{\partial V}{\partial x} + V \frac{\partial V}{\partial y}$$

is non-periodic and always in the positive direction. For most of the experimentation reported herein, the horizontal and vertical convective acceleration as calculated by Airy

wave theory was less than ten percent of the temporal acceleration in those directions. The convective contribution to the total acceleration was consequently ignored in the determination of the inertia coefficient.

Therefore, with the conclusion of this review, the mechanics of unsteady flow across a cylinder and the effect of a plane boundary on the hydrodynamic forces on the cylinder will be examined.

III. EXPERIMENTAL INVESTIGATION

Apparatus

Wave Research Facility

Experiments were conducted at the Oregon State University Wave Research Facility during August and September, 1974 to further investigate the effect of a plane boundary on a horizontal circular cylinder placed in wave flow. As shown in Figure 6 the wave basin is 104.27 m (342') long, 3.66 m (12') wide, and generally 4.57 m (15') deep and provided sufficient length and depth possibilities to generate large amplitude waves with minimum beach reflection. Beach configuration was adjusted to a 1:12 slope which provided a maximum reflection coefficient of eleven percent and a minimum of three percent with an average value of seven percent. The wave generation system is hydraulically activated and electronically controlled from a station near the test cylinder location. The system was capable of producing clean, uniform waves with wave heights up to 1.52 m (5').

Bottom configuration was established in Figure 6. Each 3.66 m (12') square concrete slab was individually lifted to provide the needed false bottom and beach configuration. Each was secured in place by heavy clip angles bolted to the sides of the wave basin. The three slabs within the test area were carefully sealed to prevent uplift currents due to

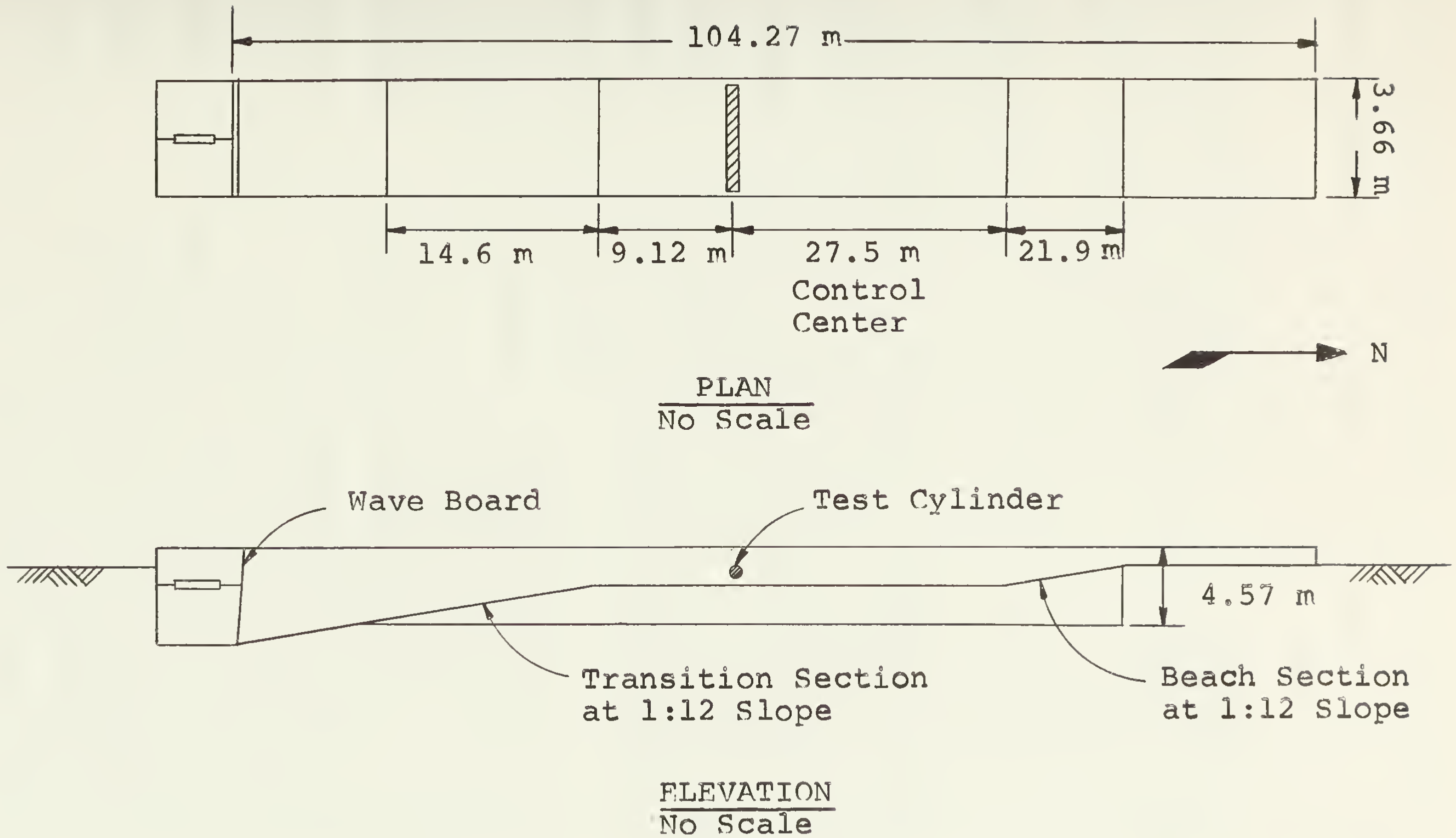


Figure 6. OSU Wave Research Facility with test cylinder.

the false bottom from altering the flow around the cylinder with the passage of a wave. The edges were sealed with strips of treated 1/2" plywood while the spaces between slabs were sealed by 1/2" x 6" x 10' lengths of flat steel plate. The test holes were sealed with No. 9 rubber stoppers. See Figure 7.

Test Cylinder

The apparatus itself was designed to fulfill the requirements of the investigation. It was a cylinder capable of transmitting wave forces in terms of deflection or strain to recording instruments. It was to remain rigid during the passage of the wave, but was also adjustable to various heights above the bottom.

As shown in Figures 7 and 8, the apparatus consisted of a three-piece 12" OD x 1/4" 6061-T6511 extruded aluminum tube where the center test section was 1.07 m (3.5') long with each of the two end sections at 1.22 m (4') long. The two end sections, or dummy sections, were required to approximate two-dimensional flow conditions around the test cylinder. The spacing between the test section and the end sections was from 3 mm to 5 mm. Two threaded 1" diameter stainless steel split-type threaded shaft collars were placed above and below the dummy section at each steel bar to hold the cylinder and steel bar rigidly. Steel guy wires extended in the direction of flow from above and below each

Figure 7. Bottom slab detail with configuration.

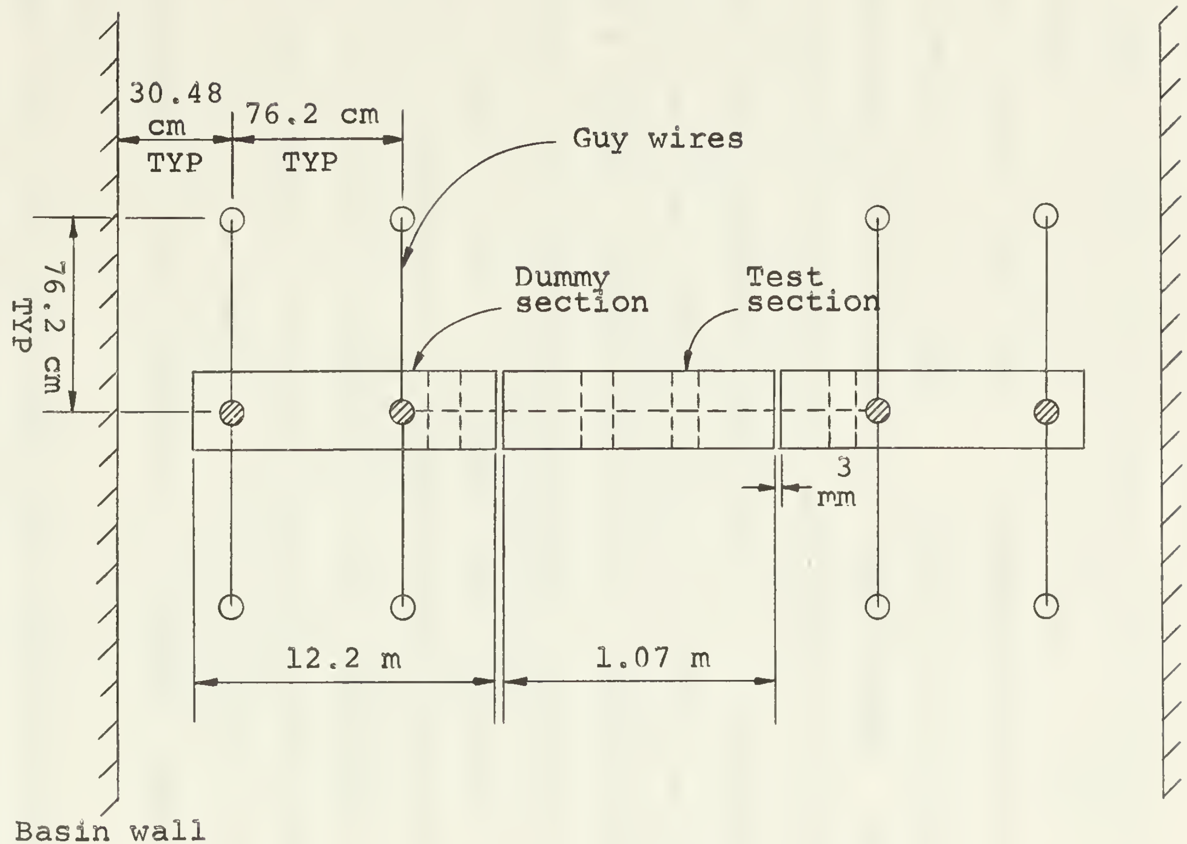


Figure 8. Test cylinder detail.

dummy section at each steel bar to points of attachment on the test slab.

Force Dynamometer

In order to measure deflections of the test cylinder from pressure distributions at its surface, a strain gage dynamometer was designed. Two 1" diameter 6061-T6 aluminum bars were machined as in Figures 9 and 10 to accommodate 16 Micro-Measurements CEA-13-189UW-120 strain gages. The gages measured horizontal and vertical deflections of the test section and were attached as in Figure 11. Each end of the test section and the adjacent ends of the dummy sections contained a rigidly fastened box of 1/2" aluminum plate through which the strain gage bars passed and were rigidly fastened. Thus, at each end of the test section the strain gage bars were represented as a beam fixed against all motion at one end and constrained to only horizontal and vertical displacement at the end within the test cylinder. The test structure was designed to have negligible deflection with respect to the diameter. All strain gages were water-proofed.

Output from the strain gages were conditioned and balanced through four Techtronix 3C66 Carrier Amplifier Bridges. Two sonic profilers were positioned above the cylinder and forward of the cylinder (toward the wave board) to measure the water surface fluctuations. The profilers

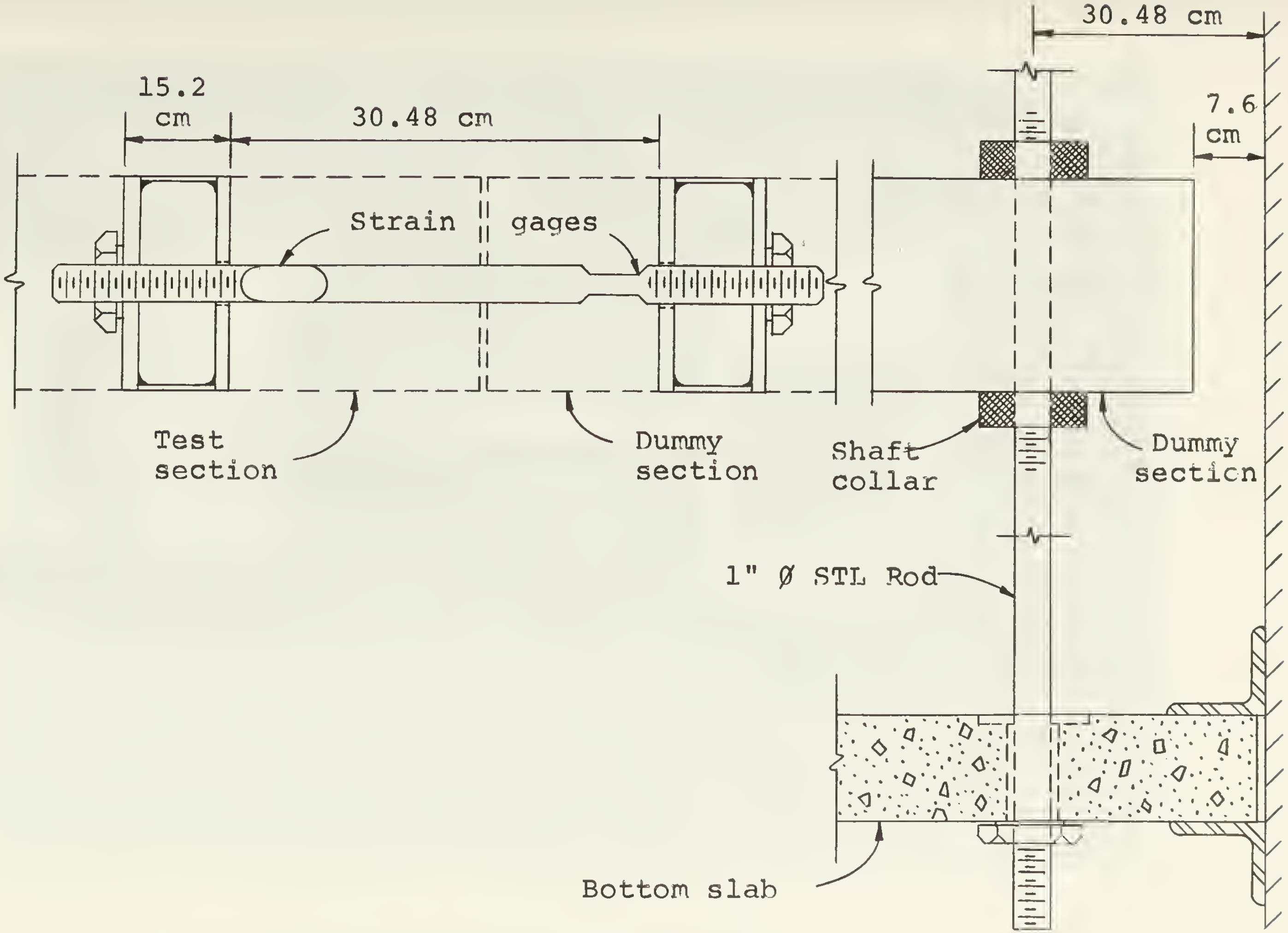


Figure 9. Force dynamometer and anchoring systems.

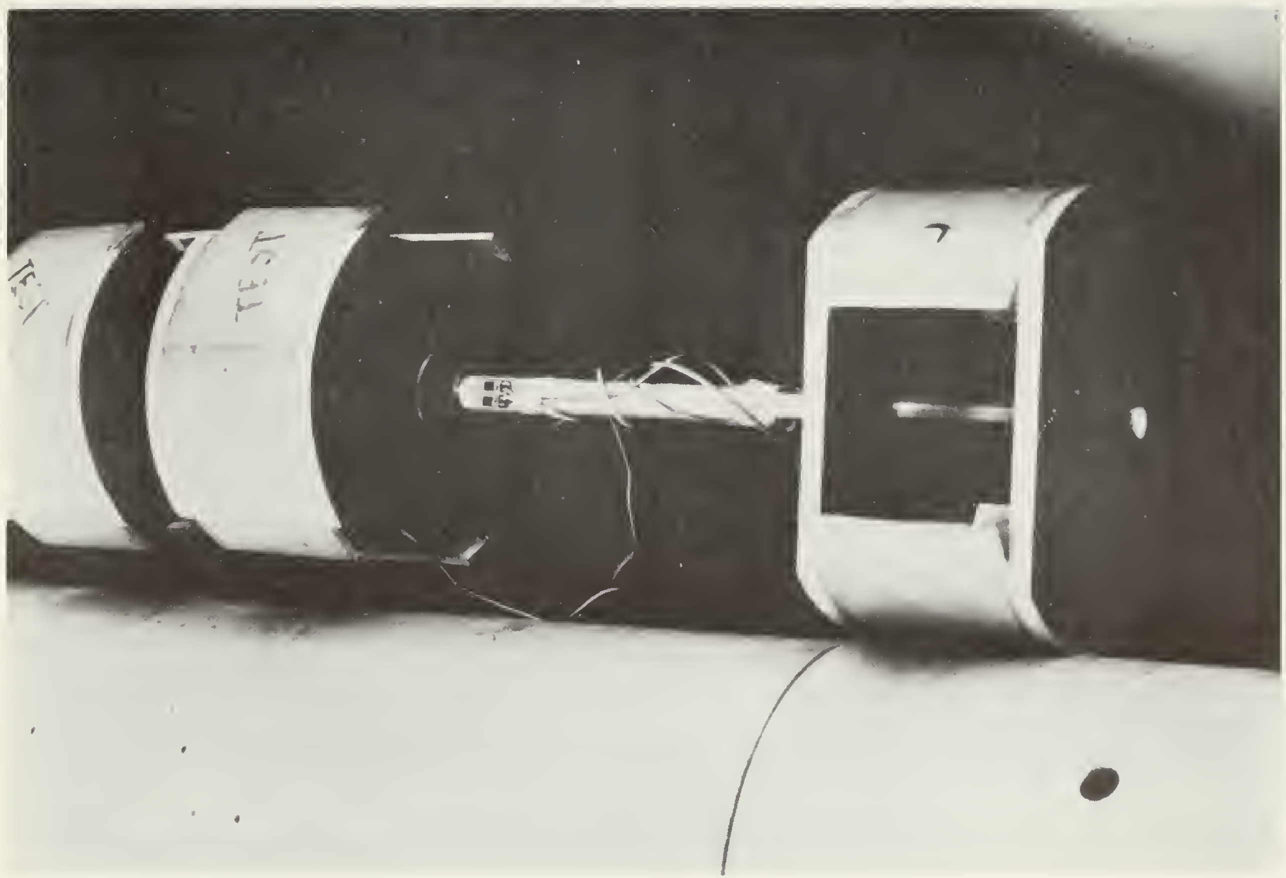


Figure 10. Force dynamometer detail.

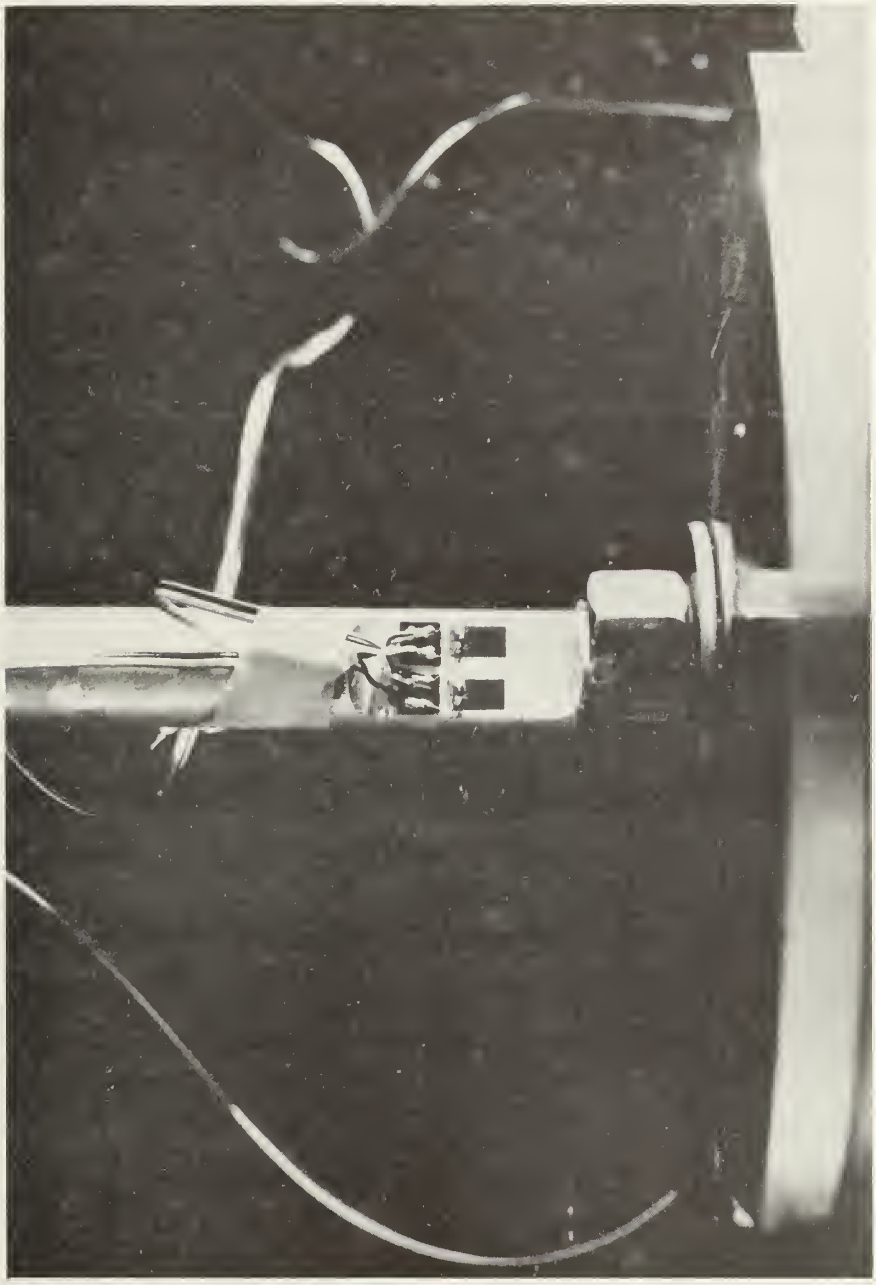


Figure 11. Strain gage detail.

were 3.94 m (12.93') apart for runs 107 to 1430 and 4.44 m (14.58') apart for runs 1501 to 1617. Conditioned signals from the strain gages and signals from both profilers were recorded on a twelve-channel Honeywell 1508 Visicorder. The signal from the sonic profiler over the cylinder was also recorded at the wave generating station by a Hewlett-Packard two-channel chart recorder.

Test Procedure

A series of four water depths were designed in an array with six gaps between the cylinder and the plane boundary. Values for water depths and gaps were:

h [m (ft)]		e [cm (in)]	
0.716	(2.35)	0	
0.957	(3.14)	1.27	(0.5)
1.62	(5.32)	3.175	(1.25)
2.38	(7.8)	5.08	(2.0)
		15.24	(6.0)
		30.48	(12.0)
		60.96	(24.0)

Of these 24 combinations, 16 were chosen to be investigated. Each of the 16 combinations contained individual runs of varying wave periods and wave heights. Specific ranges were:

T : 0.96 to 6.20 sec

H : 5.76 cm (0.189') at h = 71.6 cm (2.35') to
98.51 cm (3.23') at h = 2.38 m (7.8')

H/T^2 : 0.0085 to 0.505 ft/sec^2

h/T^2 : 0.078 to 2.57 ft/sec^2

Re : 2.0 x 10^3 to 2.0 x 10^5 (based on maximum horizontal velocity).

Thus, the experimental schedule was designed to establish information on the effect of a plane boundary on wave forces on a horizontal cylinder whose longitudinal axis was perpendicular to the direction of flow.

The test procedure covered the following steps:

1. The test cylinder was lowered or raised to the position of the required experimental configuration. Movement of the cylinder was controlled by a chain hoist and spreader bar for slow, even adjustment so as not to overstrain the strain gages. With the proper configuration, shaft collars were secured and guy wires adjusted to maintain a rigid structure.

For the cylinder at e = 0, strips of foam rubber 2.5 cm (1") thick were placed between the test cylinder and the bottom as a flow barrier with the cylinder and the bottom as a flow barrier with the cylinder secured at the position of e = 1.27 (0.5"). For runs 6 and 12, the foam rubber barrier was also placed between the dummy sections and the bottom. The resistance of the foam rubber to vertical loading of the test cylinder was assumed negligible and no external calibration of the cylinder was conducted for this configuration. Therefore, the only difference between the set up

of configurations for e = 0 and e = 1.27 cm (0.5") was the insertion of the foam rubber barrier. The adjustments to the test cylinder were all conducted while submerged using two personnel in scuba gear. Each adjustment generally took 30 minutes time.

2. The wave generator was set to the required frequency and amplitude. Check runs were required occasionally to assure the generation of the proper wave.

3. With still water in the wave basin, each pair of strain gages were balanced and internally calibrated prior to each run.

4. The test wave was then generated and results from the strain gages and sonic profilers were recorded.

The above steps were repeated for each run at each required water depth.

Calibration Procedure

The response of the test cylinder to horizontal and vertical forces was calibrated four different times during experimentation. As shown in Figure 12, known weights were attached to the test section via a minimum friction pulley system in the negative horizontal and positive vertical directions. Calibration of the test cylinder was not conducted in the positive horizontal and negative vertical directions because of the symmetry of the force dynamometer system. The microstrains recorded were then correlated to

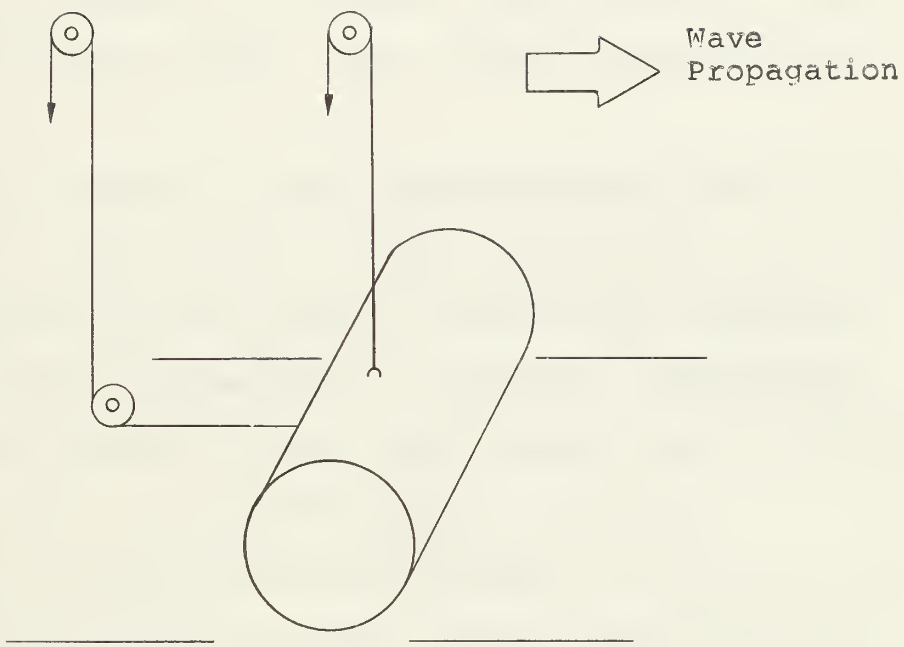


Figure 12. Horizontal and vertical calibration setup.

the known forces. The correlation remained nearly constant throughout the testing schedule.

Natural Frequency of System and Resonance

At the conclusion of all scheduled test runs the natural frequency of the structure was roughly determined by recording the frequency of vibration after giving the test cylinder an initial impulse. The following results were obtained:

1. For cylinder in air, guyed above and below, with $e = 60.96$ cm (24"): $f_V = 23$ Hz and $f_H = 11.5$ Hz where f_V and f_H are the vertical and horizontal natural frequencies of vibration, respectively.
2. For cylinder in air, guyed above, with $e = 15.24$ cm (6.0"): $f_V = 23$ Hz and $f_H = 15.0$ Hz.
3. For cylinder in water at depth $h = 1.07$ cm (3.5'), guyed above and below, with $e = 60.96$ cm (24"): $f_V = 8.0$ Hz and $f_H = 5.25$ Hz.

The natural frequency thus determined is sufficiently greater than expected frequencies of transverse vibrations due to vortex shedding such that a resonance condition is unlikely to occur. This can be shown with the crude use of the Strouhal number which is a similarity parameter expressed as:

$$S = \frac{f_s D}{U}$$

where f_s = frequency of transverse vibrations due to vortex shedding. If S = 0.21 over the range $10^3 < Re < 10^5$ and U = 1.07 m/sec then f_s = 0.7 Hz for this test cylinder. Thus, for the case where e/D = 2.0,

$$\frac{f_V}{f_s} = 11.4 >> 1.$$

IV. RESULTS AND DISCUSSION

Calibration Factors

Results of the calibration procedures described in Chapter III are plotted in Figures 13 and 14. A linear regression procedure was applied to obtain a best fit line between the values of microstrain and calibration loading. This relationship yielded the calibration factor for both the horizontal and vertical forces such that the microstrain recorded from the movement of the test cylinder when multiplied by this factor yielded the total load on the test cylinder. The resulting calibration factors used throughout the data reduction procedure were:

$$C_H = 0.252 \text{ pounds/microstrain}$$

$$C_V = 0.189 \text{ pounds/microstrain}$$

Wave Force Data Reduction

Horizontal and vertical wave force traces and two wave profile traces were reduced for each run to yield the force data found in Appendix B. Wave celerity and observed wave length were calculated for most runs utilizing the known distance between the two sonic profilers.

Raw data for each run were composed of six traces, four of which were the variations of strain in the horizontal and vertical directions for both the left (west) and right

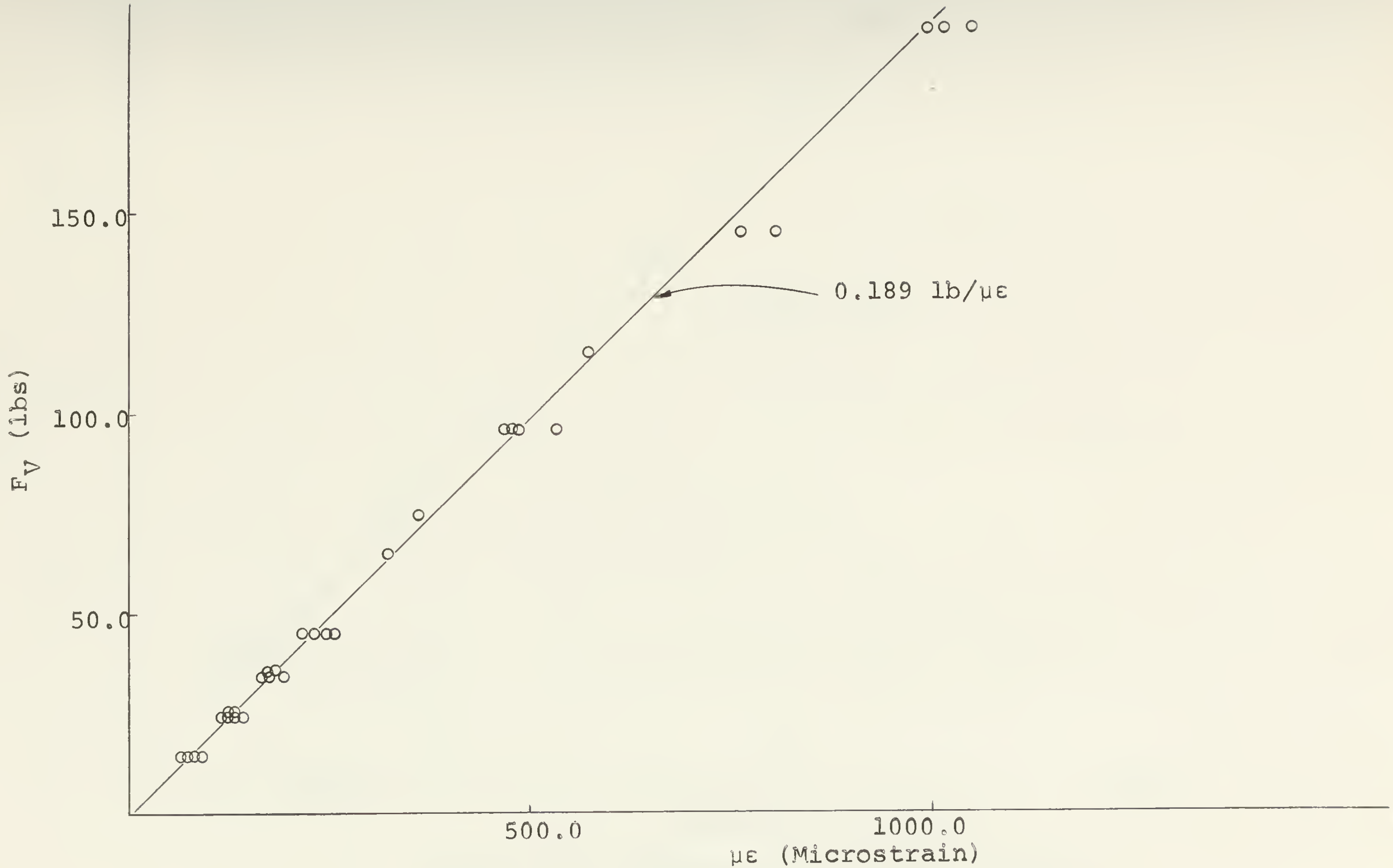


Figure 13. Vertical calibration factor.

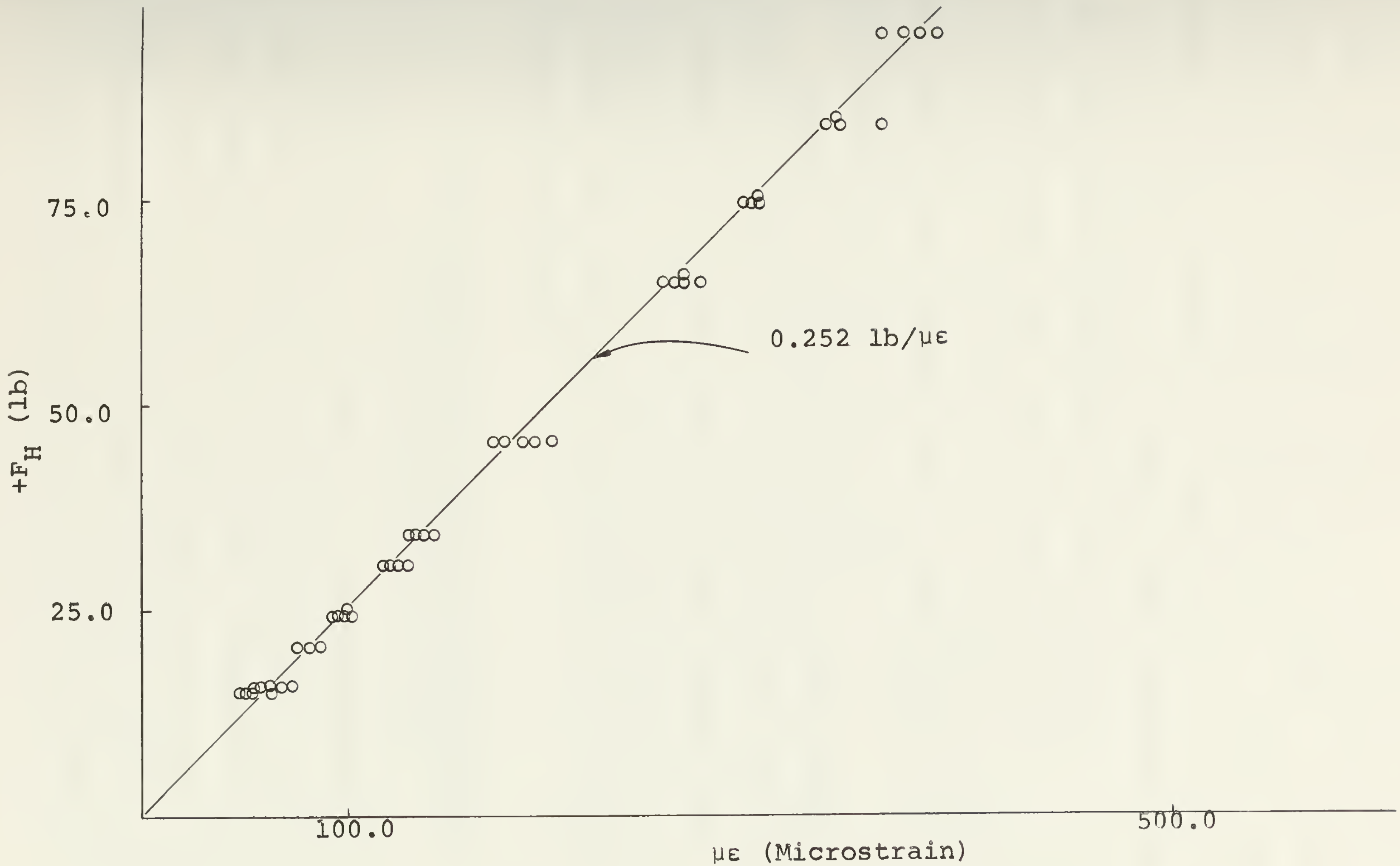


Figure 14. Horizontal calibration factor.

(east) ends of the test cylinder. This duplication of strain readings provided a check on the alignment of the force rod at either end of the test cylinder. The forces were equal at both ends of the cylinder. However, the four gages on the right end of the test cylinder which recorded vertical deflections gave signals which continually drifted and prohibited determination of vertical forces. Thus, the results from the eight left end gages were used to provide the horizontal and vertical forces listed in Appendix B. The remaining two traces were the wave profile forward of the cylinder and above the cylinder.

Appendix A contains the results of the computer routine which calculated various flow parameters for each run according to Airy wave theory utilizing experimental wave profile data. For all cases, the wave length calculated from Airy wave theory was utilized in lieu of observed values of wavelength.

Flow Mechanics and Effect of Plane Boundary and Fluid Displacement on Forces

As discussed in Chapter II, the hydrodynamic forces on a horizontal cylinder during the passage of a wave vary with the proximity of the plane boundary, expressed as e/D, and the relative horizontal displacement of the water particles, expressed as A/D. Utilizing experimental results and the analytical and empirical considerations of Chapter II, the

mechanics of flow around a horizontal cylinder will be described for three cases.

Case 1 will consider the flow around a horizontal cylinder sealed to the plane boundary. Runs 605, 612, and 620 will be discussed for which $e/D = 0$.

Case 2 will consider a horizontal cylinder near the plane boundary so that the definite effects of the plane boundary on the forces will be determined. Runs 705, 709, 718, and 725 will be discussed for which $e/D = 0.042$.

Case 3 will exhibit the flow around a cylinder in an infinite fluid. Essentially this will mean that the cylinder will experience no effects from a plane boundary or free surface. As shown by Wilson _et_ _al_. (14) and Yamamoto _et_ _al_. (15), the lift force on a horizontal cylinder for $e/D = 1.0$ is five percent to fifteen percent of the drag force with Reynolds numbers of 10^4 to 10^5. Runs 1110, 1118, and 1120 where $e/D = 1.0$, will be utilized to describe this case.

Thus, the location of the plane boundary and the transition from potential flow to the characteristics of real flow produces important variations in the types and directions of forces on the horizontal cylinder. As found in Chapter II, one of the most useful parameters for locating transition points is A/D, the ratio of the maximum horizontal particle displacement to cylinder diameter. The value of the maximum horizontal particle displacement utilized throughout this investigation was calculated by Airy wave theory.

Case 1 - Cylinder Resting on Plane Boundary where $e/D = 0$

For a cylinder resting on and sealed to a plane boundary, it is well known that the horizontal velocity will result in horizontal forces due to the pressure drag of the wake when the wake develops and positive vertical forces due to the asymmetry of the flow around the cylinder. Also, the horizontal acceleration will produce horizontal inertia forces. The vertical velocity and acceleration are very small near the bottom and have a negligibly small effect on the cylinder compared with other forces. Figures 15, 16, and 17 show the experimental results for runs 605, 612, and 620 where values of A/D are 0.09, 0.51, and 3.20 respectively.

From examination of all data for $e/D = 0$, the following general tendencies were found. For $A/D < 0.3$, the data show the horizontal and vertical force variations remain nearly sinusoidal and increase linearly with wave height. Thus, at small values of particle displacement the flow is essentially potential flow and both horizontal and vertical forces are due to particle acceleration, as exemplified by the results for run 605 in Figure 15. For $A/D > 0.3$, as shown in Figure 16, the vertical force variation ceases to be sinusoidal and begins to deform to exhibit two positive and two negative force peaks. It is at this value of A/D that $+F_{Vmax}$ remains greater than $-F_{Vmax}$. The positive vertical

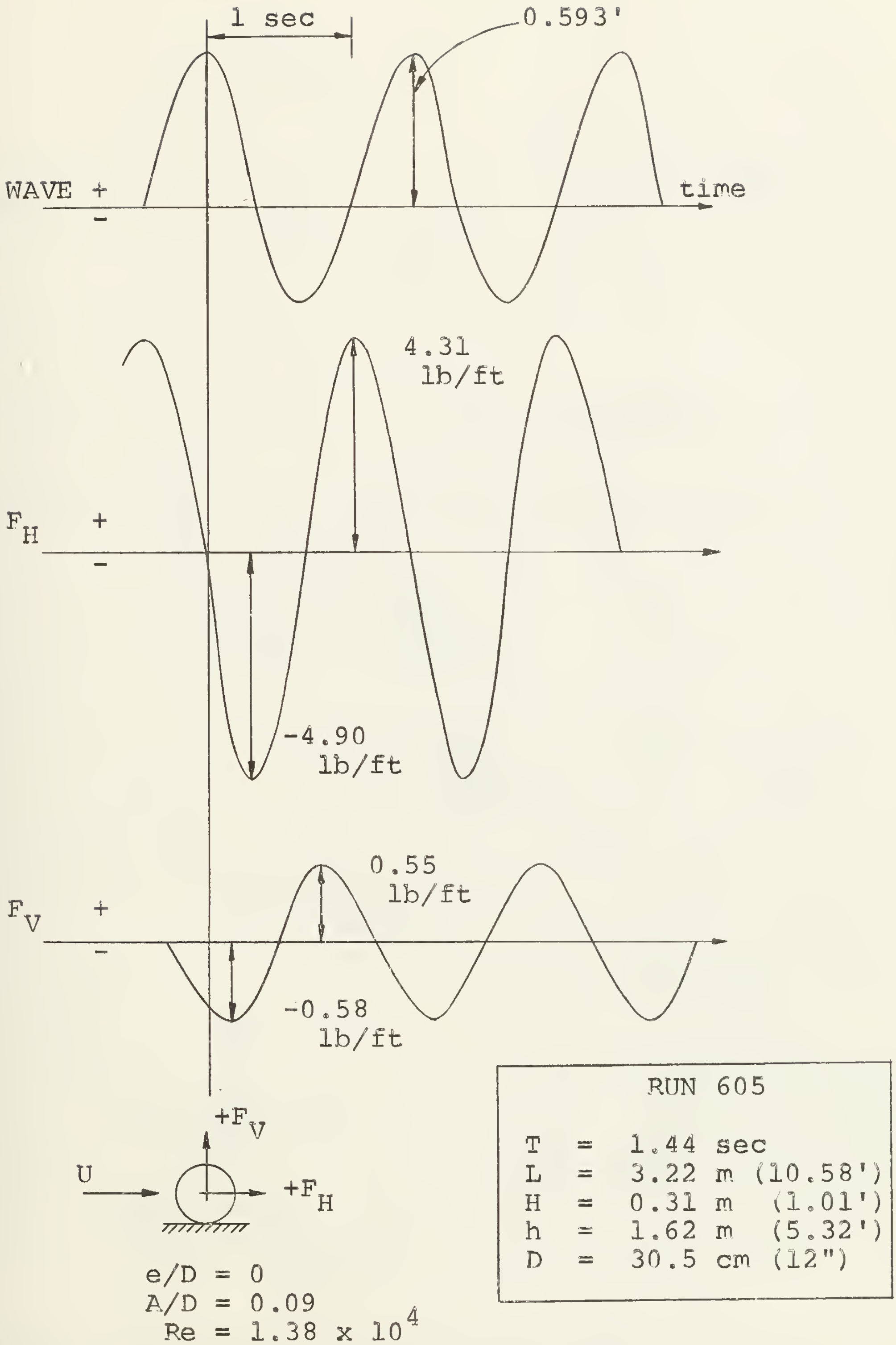
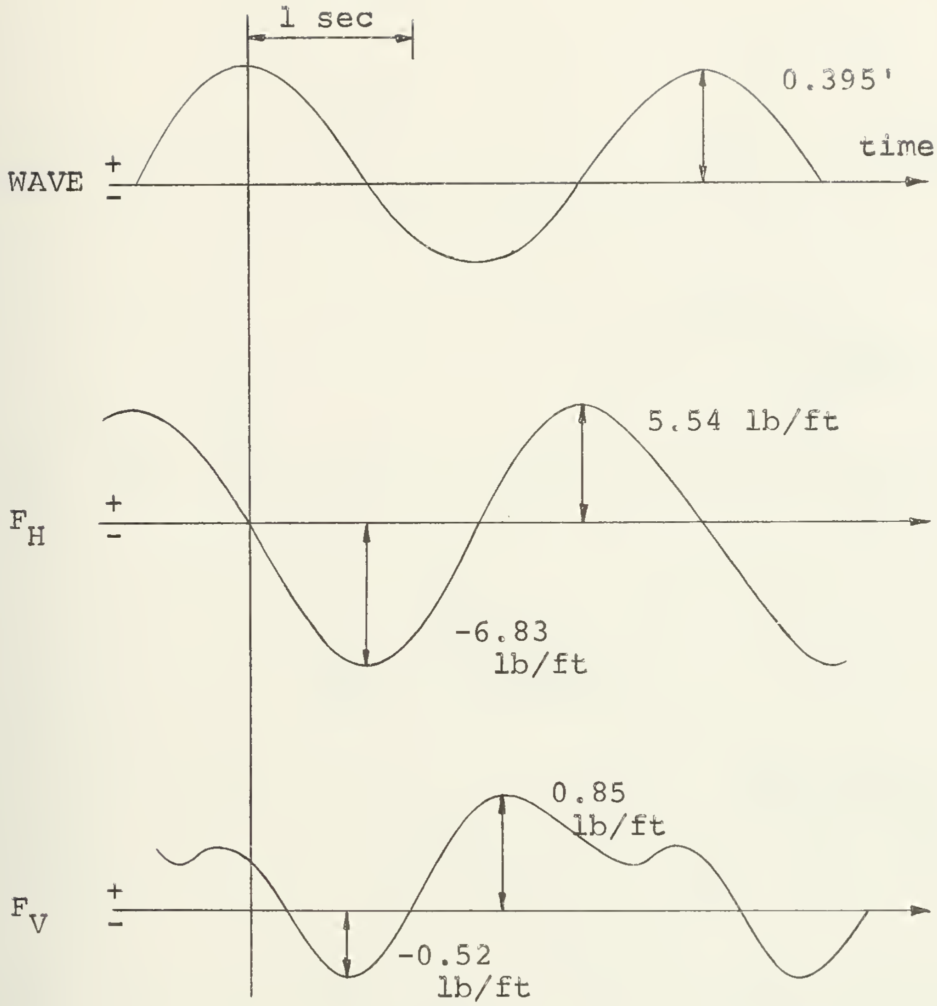
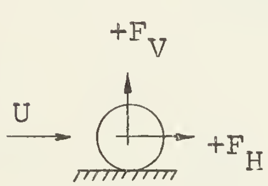


Figure 15. Horizontal and vertical forces e/D = 0.

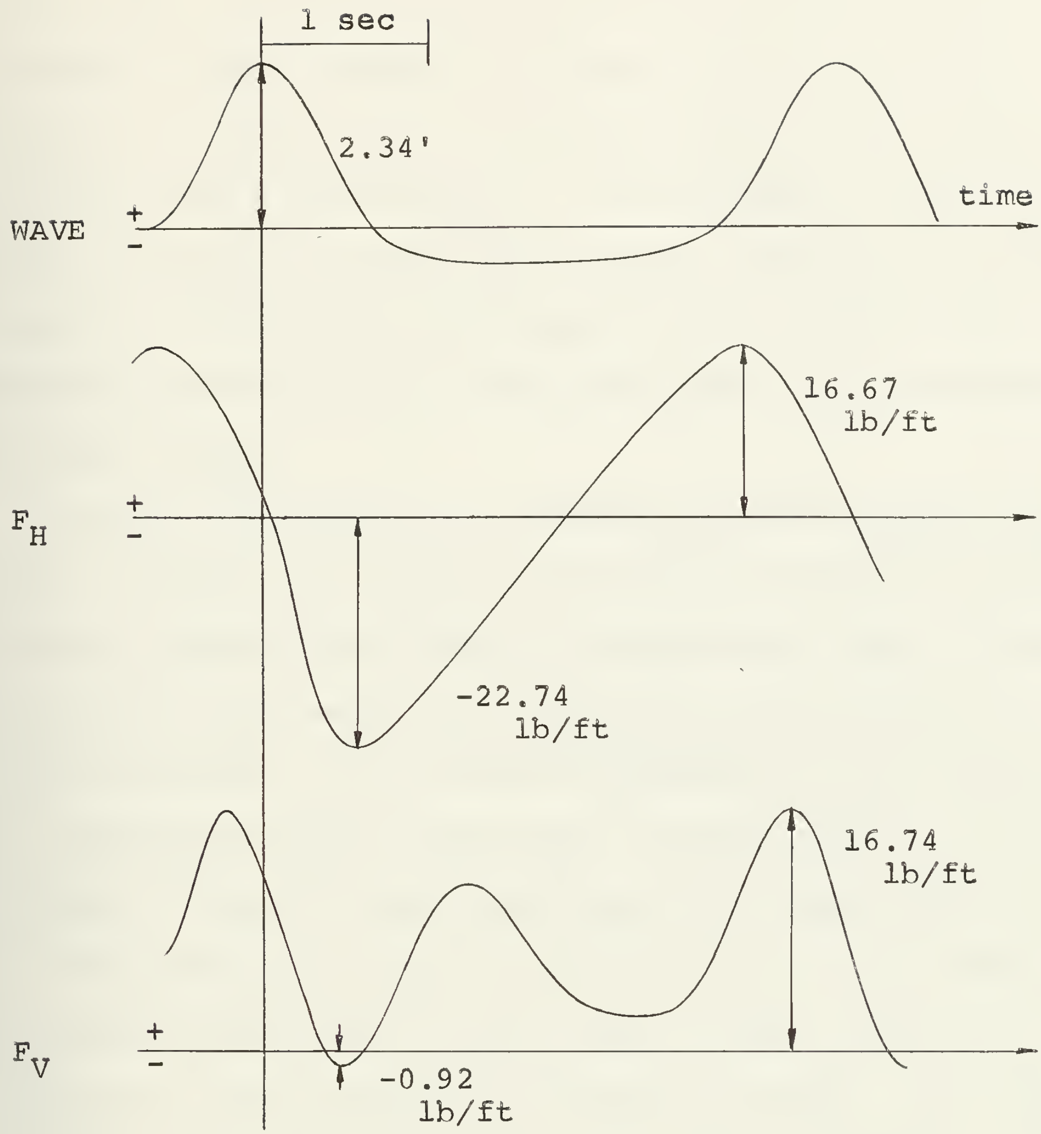


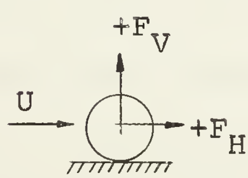


$e/D = 0$
$A/D = 0.51$
$Re = 4.02 \times 10^4$

RUN 612		
T	=	2.82 sec
L	=	9.69 m (31.8')
H	=	0.19 m (0.639')
h	=	1.62 m (5.32')
D	=	30.5 cm (12")

Figure 16. Horizontal and vertical forces, $e/D = 0$.





$e/D = 0$
$A/D = 3.20$
$Re = 1.99 \times 10^5$

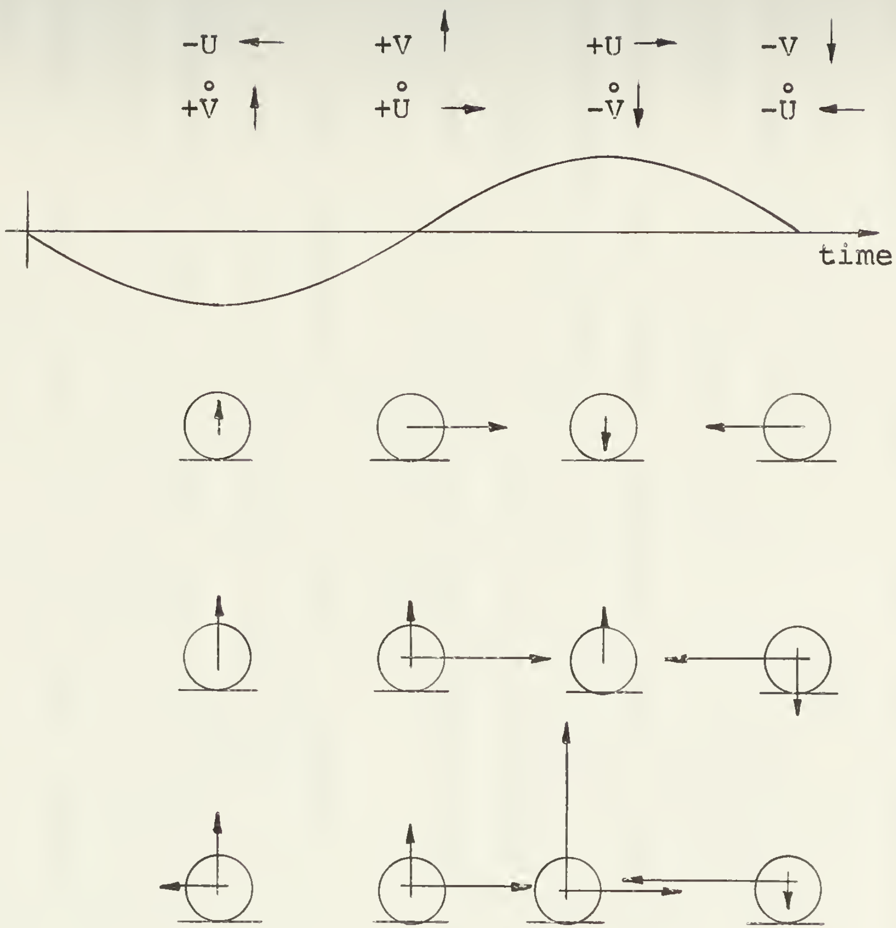
RUN 620

T = 3.55 sec
L = 12.97 m (42.56')
H = 0.85 m (2.78')
h = 1.62 m (5.32')
D = 30.5 cm (12")

Figure 17. Horizontal and vertical forces, e/D = 0.

force peaks increase proportionally to the wave height squared and this parabolic increase verifies that they represent a positive lift force generated by the asymmetrical flow across the cylinder. The horizontal forces remain nearly sinusoidal in variation for all values of A/D investigated with deviations attributed to wave nonlinearity. The maximum horizontal forces remained larger than the maximum vertical forces.

Figure 18 represents a summary of the foregoing discussion. It shows the temporal variation of the wave surface with the expected positions of the maximum values of horizontal and vertical velocities and accelerations according to Airy wave theory. The relative magnitude of the experimental values of the horizontal and vertical forces of the cylinder at various wave phases are also shown schematically. From this the inertia dominated flow at low values of A/D can be seen as well as the onset of the horizontal drag force due to wake effects at large A/D values. The negative vertical force under the node of the wave increases linearly with wave height and thus is proportional to the vertical acceleration. The location of the force at a wave phase where, according to Airy wave theory, the vertical acceleration is zero, exhibits the inaccurate prediction of the vertical acceleration by that theory. As was shown in Figure 5, the difference between $\mathring{V}$ according to Airy theory and $\mathring{V}$ according to the Stream function is quite marked in both magnitude and direction for nonlinear waves.



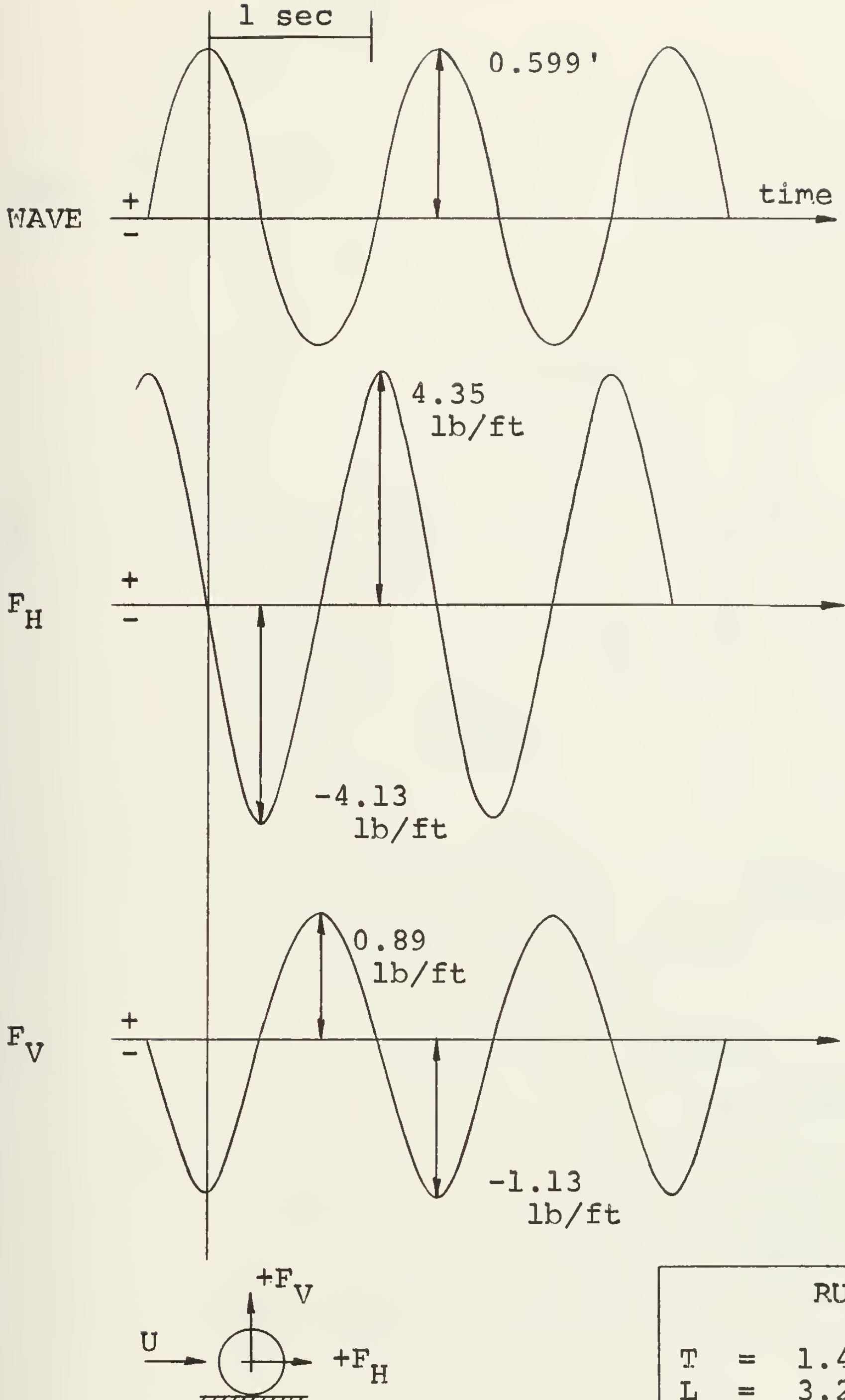
A/D	RUN
0.09	605
0.51	612
3.20	6.20

Figure 18. Horizontal and vertical force transition from potential to wake flow, e/D = 0.

Case 2 - Cylinder Near Plane Boundary where $0 < e/D < 1.0$

It has been shown that the lift force due to flow asymmetry is always upward for both potential flow and wake flow when $e/D = 0$. The transition from potential flow to wake flow is less clear for the case where a cylinder is near a plane boundary. As mentioned in Chapter II, one can now expect negative lift forces to occur from the horizontal velocities due to potential flow effects. It will be shown that positive lift forces also occur due to horizontal wake effects. The remaining inertia and drag forces in the horizontal and vertical directions occur as the result of corresponding accelerations and velocities similar to Case 1. Figures 19, 20, 21, and 22 give experimental results for runs 705, 709, 718, and 725 where values of A/D are 0.09, 0.41, 1.62, and 3.43 respectively.

From examination of all data for which $0.04 \leq e/D \leq 0.5$, the following observations were made. A small particle displacement again indicated that a wake has little chance of developing around the cylinder and consequently the forces on the cylinder can be discussed according to potential flow considerations. For $A/D < 0.25$, the horizontal and vertical forces vary nearly sinusoidally and result from an inertia dominated potential flow as in Figure 19. For larger values of A/D where $0.5 < A/D < 1.0$, and still within potential flow as in Figure 20, the horizontal velocity contributes to negative vertical forces since the higher



$e/D = 0.042$
$A/D = 0.09$
$Re = 1.44 \times 10^4$

RUN 705

T	=	1.44 sec
L	=	3.22 m (10.58')
H	=	0.32 m (1.05')
h	=	1.62 m (5.32')
D	=	30.5 cm (12")

Figure 19. Horizontal and vertical forces, e/D = 0.042.

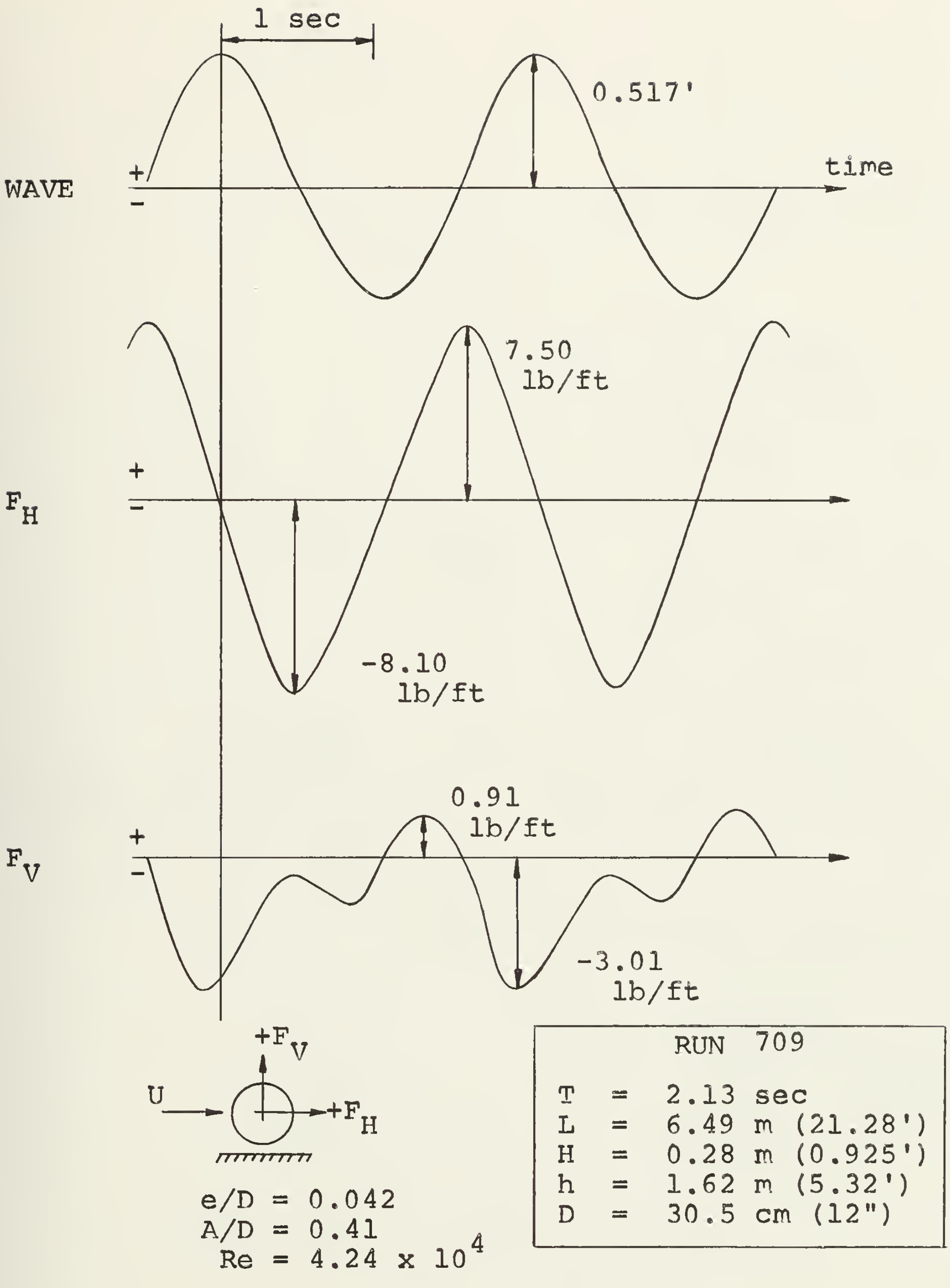


Figure 20. Horizontal and vertical forces, e/D = 0.042.

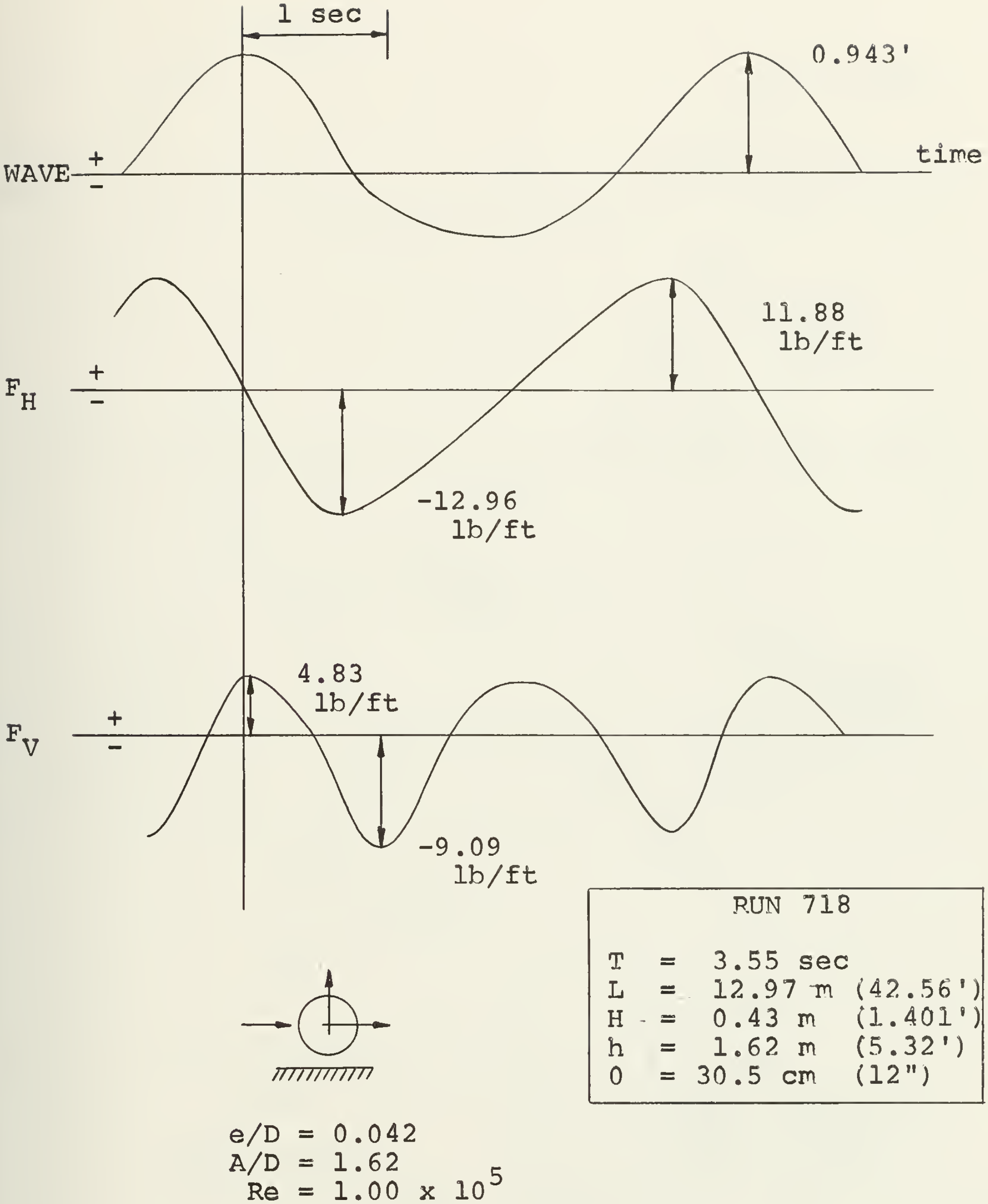


Figure 21. Horizontal and vertical forces, e/D = 0.042.

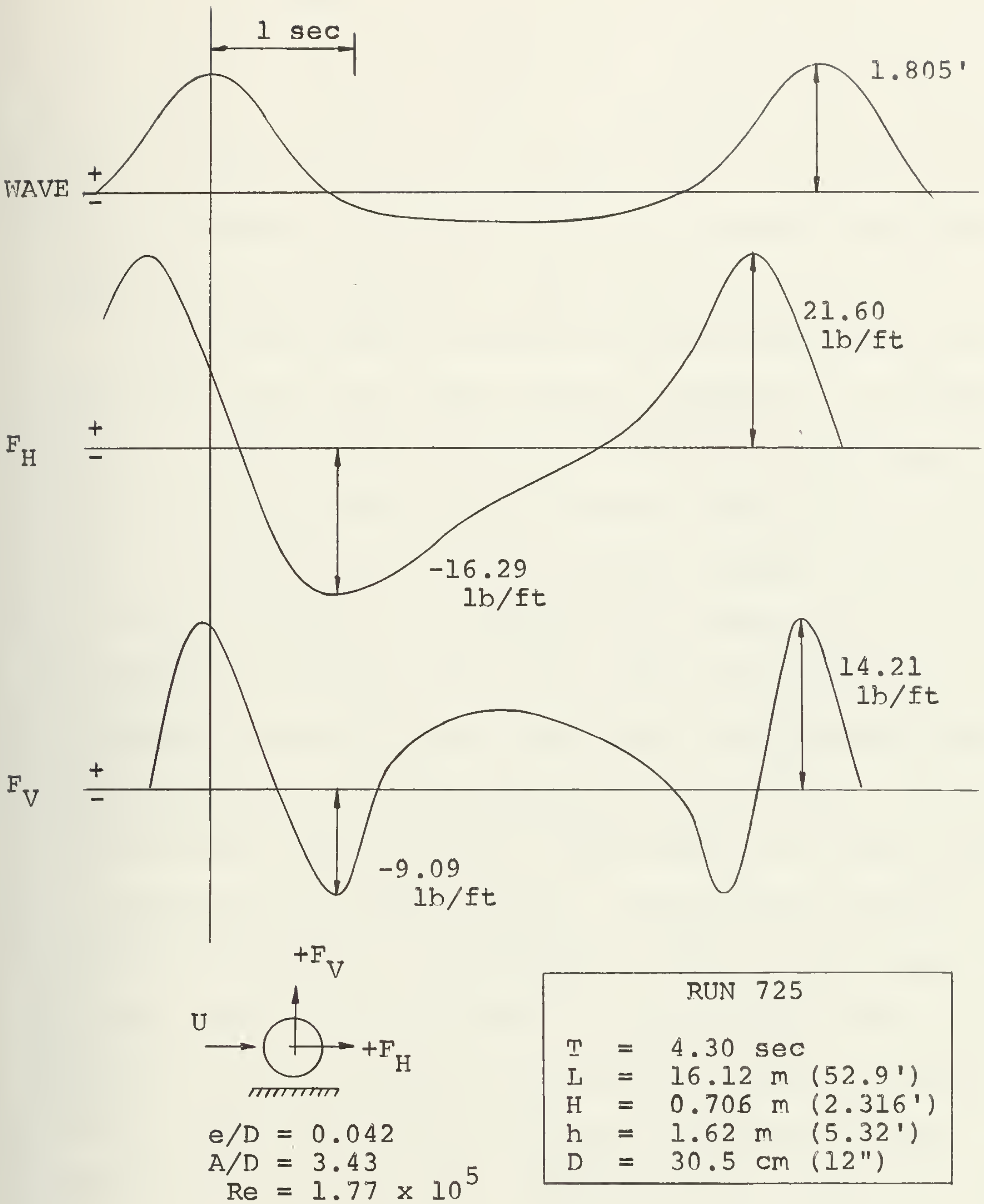


Figure 22. Horizontal and vertical forces, $e/D = 0.042$.

velocity flow between the cylinder and the boundary generates a lower pressure in this area. These observations can be verified. For $A/D < 0.25$, $-F_V$ occurring near the wave crest is proportional to wave height and for greater particle displacement, the variation in $-F_V$ becomes nonlinear increasing with respect to H and proportional to H^2.

On the other hand, a large particle displacement implies that a wake will form and the forces on a cylinder must now include real flow or wake effects. In Figures 21 and 22, the horizontal forces become a combination of inertia and drag forces but less obvious changes occur with the vertical forces. In Figure 21 for which $A/D = 1.62$ the negative vertical force peak under the crest of the wave has shifted forward of the crest and a positive vertical force exists under the trough of the wave. Thus, the positive vertical force is a lift force due to the wake behind the cylinder as in steady flows. The existence of this positive lift force is explained as follows. The wake slows the flow between the cylinder and the boundary from the increase in negative pressure behind the cylinder resulting from the clockwise rotation of the lower point of flow separation on the cylinder. Higher flow is readjusted over the cylinder and the pressure gradient becomes negative upward. This wake effect may be referred to as a "hydraulic barrier."

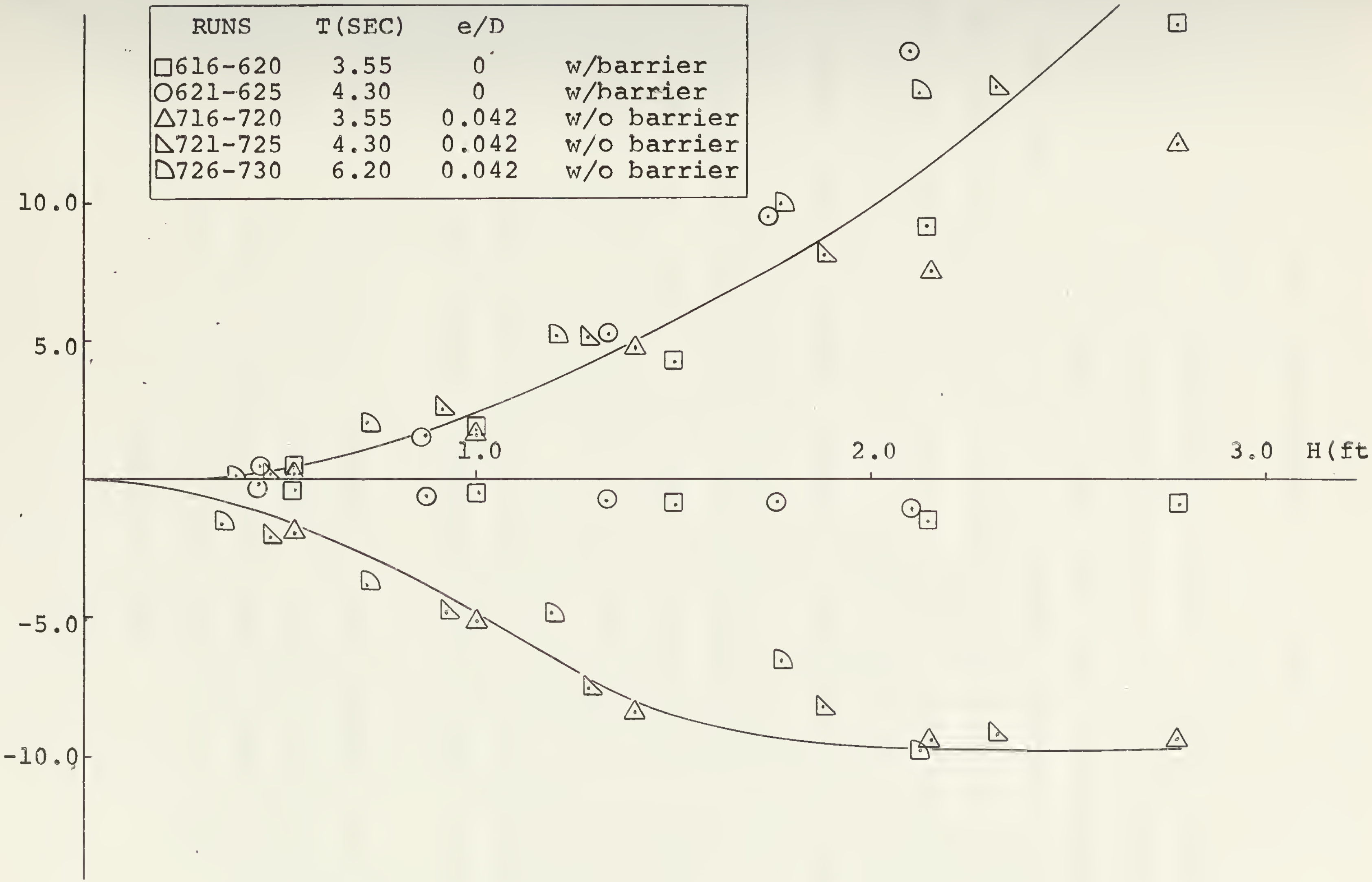
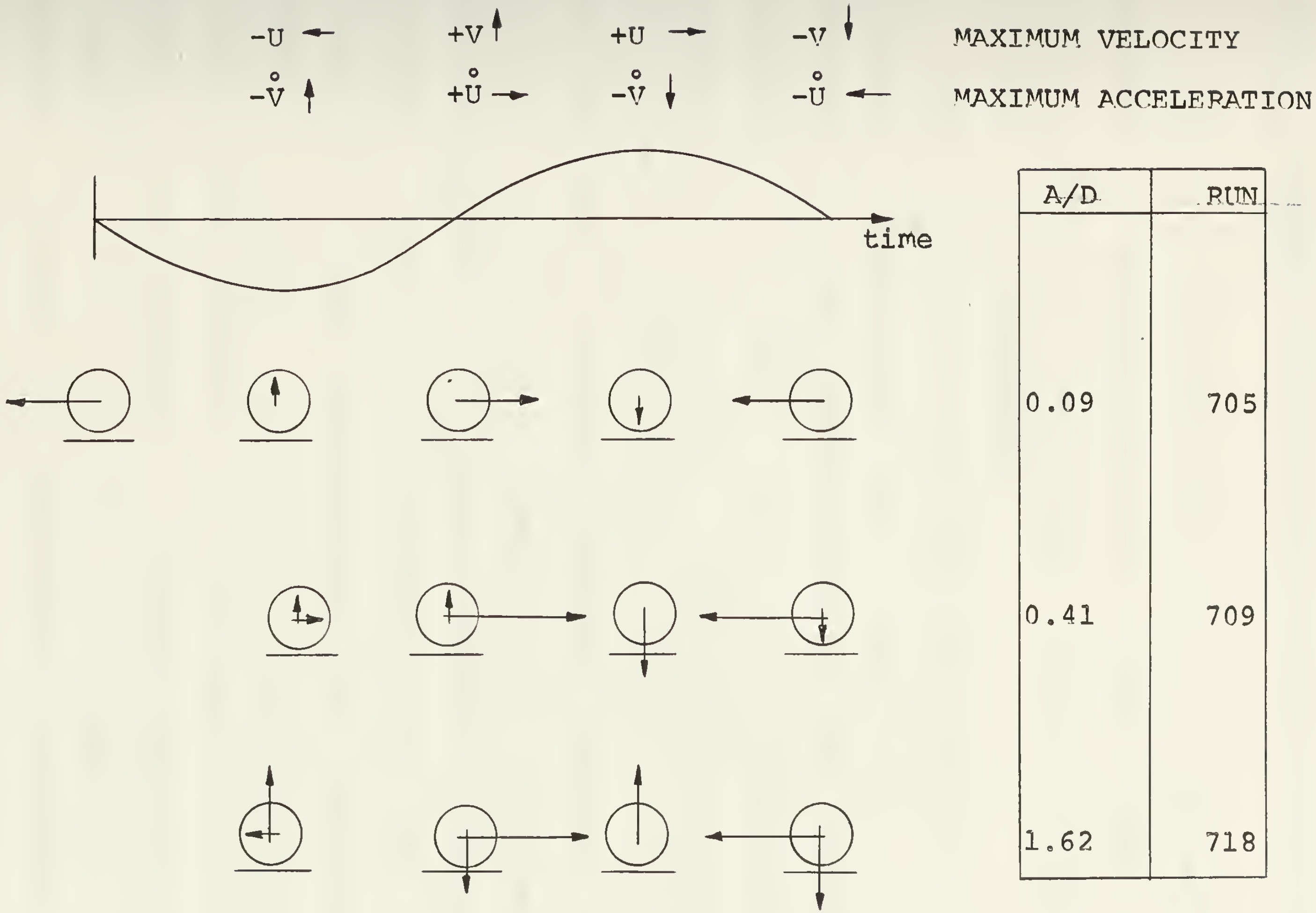


Figure 23. Positive and negative vertical forces vs wave height e/D = 0.0 and e/D = 0.04.

The concept of a "hydraulic barrier" is substantiated in Figure 23. This figure compares the positive lift forces discussed previously for $e/D = 0$ to the positive lift forces for $e/D = 0.042$. As explained in Chapter III, the change from the experimental configuration for the 700 numbered runs to the 600 numbered runs was made with the insertion of a foam rubber barrier between the cylinder and the bottom. The positive vertical force increases parabolically with H for both cases of $e/D = 0$ and $e/D = 0.042$. The similarity in the positive vertical forces suggests that the "hydraulic barrier" acts in a manner similar to the foam rubber barrier. The negative vertical force for $e/D = 0.042$ first increases parabolically with H and approaches a constant value for $A/D > 1.5$, whereas the negative vertical force for $e/D = 0$ stays negligibly small for all H. Therefore, for the case where $0 < e/D < 1.0$ and $A/D > 1.5$, the cylinder experiences large alternating lift forces occurring at twice the wave frequency. This suggests a possible failure mode for submarine pipelines.

Figure 24 presents a summary of the foregoing discussion in a format similar to Case 1. Again, as discussed in Case 1, the negative vertical force under the node of the wave, in contradiction to Airy wave theory, may be due to $-\overset{\circ}{V}$ if a higher order wave theory is used.



A/D	RUN
0.09	705
0.41	709
1.62	718

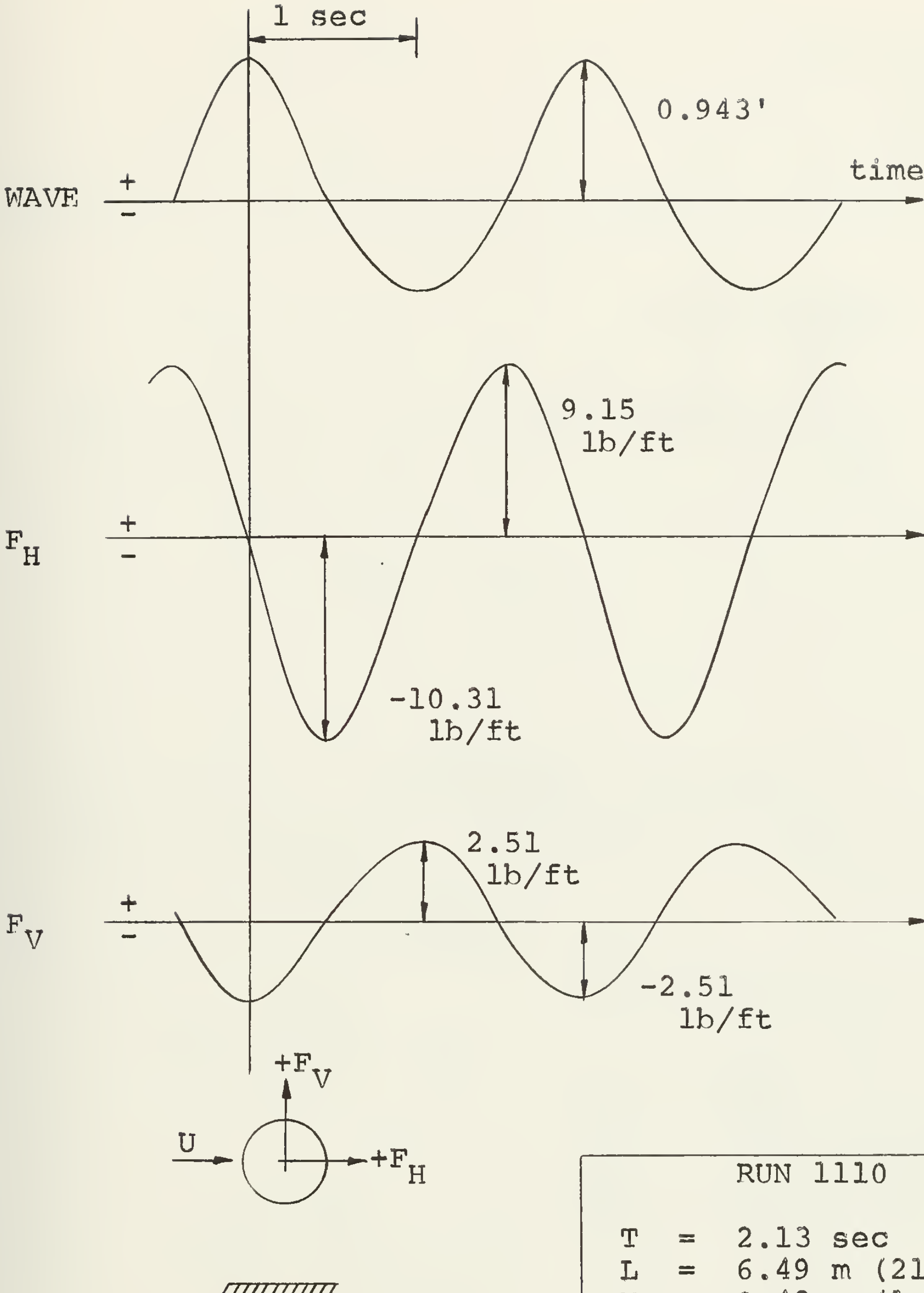
Figure 24. Horizontal and vertical force transition from potential to wake flow, e/D = 0.042.

Case 3 - Cylinder Far from Plane Boundary and Free Surface where $e/D \geq 1.0$

Figures 25, 26 and 27 for runs 1110, 1118, and 1120 are presented for this case where the cylinder is far from the bottom boundary and free surface. Values of A/D are 0.75, 1.72 and 3.18, respectively.

From examination of all data for which $e/D \geq 1.0$, the following tendencies were noted. For $A/D < 2.0$, the negative vertical force peak near the wave crest increases in proportion to H. For $2.0 \leq A/D \leq 3.0$, $-F_V$ increases nonlinearly with H and at $A/D > 3.0$ this rate of increase slows. This trend for vertical forces is similar to that of Case 2, but the transition occurs at different A/D values. At $A/D = 3.0$ the wake should already be well developed such that the decrease in $-F_V$ cannot be completely explained by assuming a transition from potential to real flow, unless values of A/D calculated according to Airy theory are in error. In addition, there exists no appreciable phase shift of the $-F_V$ peak forward of the wave crest as was observed in Case 2. This observation is expected since there exists no appreciable positive lift force in the absence of a plane boundary. In Case 2, the generation of the positive lift force at the wave crest resulted in shifting the negative vertical force peak forward of the wave crest.

The vertical forces vary with one negative and one positive force peak for $A/D < 0.8$ characteristic of an



RUN 1110

T = 2.13 sec
L = 6.49 m (21.3')
H = 0.48 m (1.562')
h = 1.62 m (5.32')
D = 30.5 cm (12")

e/D = 1.0
A/D = 0.75
Re = 7.77×10^4

Figure 25. Horizontal and vertical forces, e/D = 1.0.

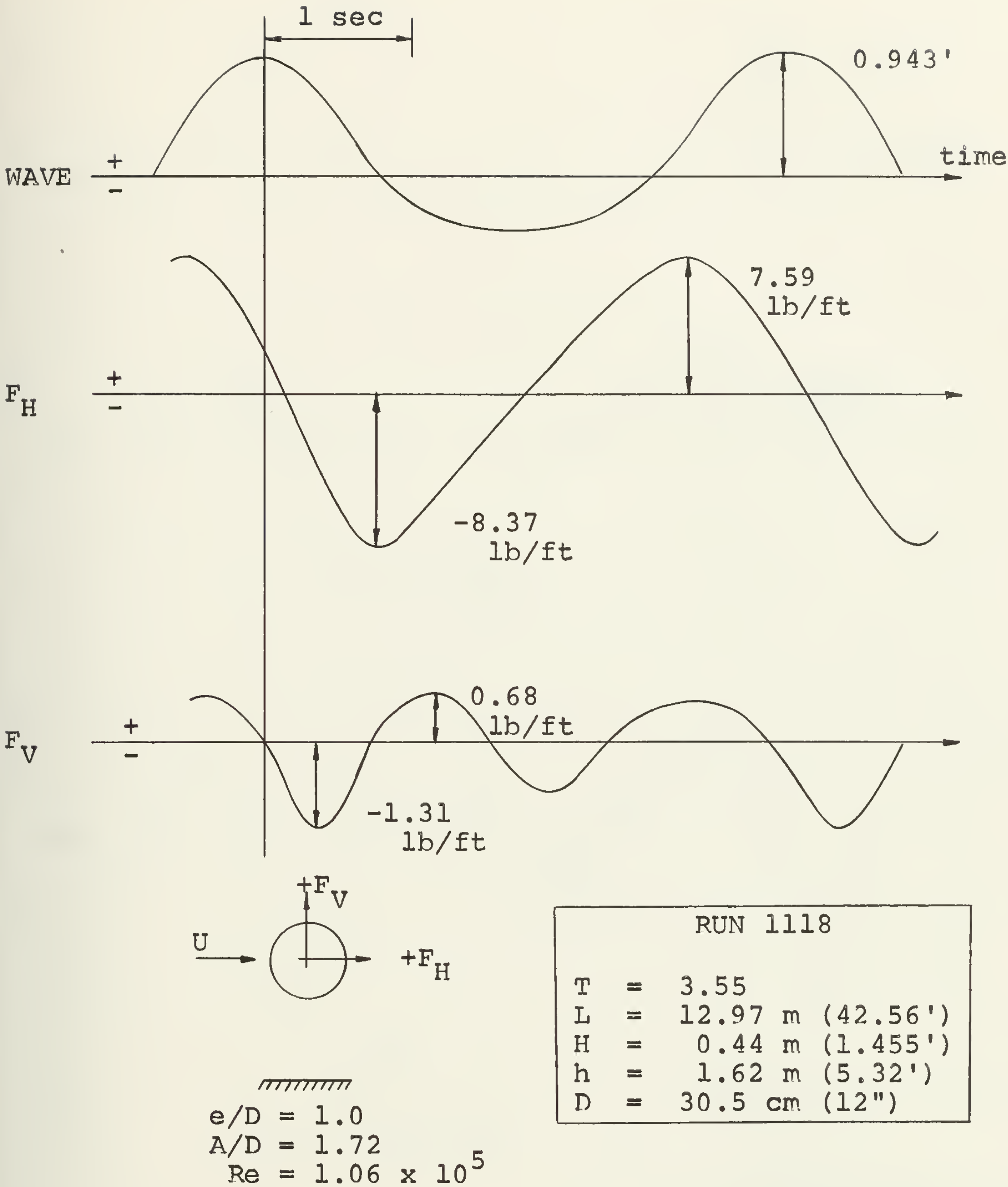


Figure 26. Horizontal and vertical forces, e/D = 1.0.

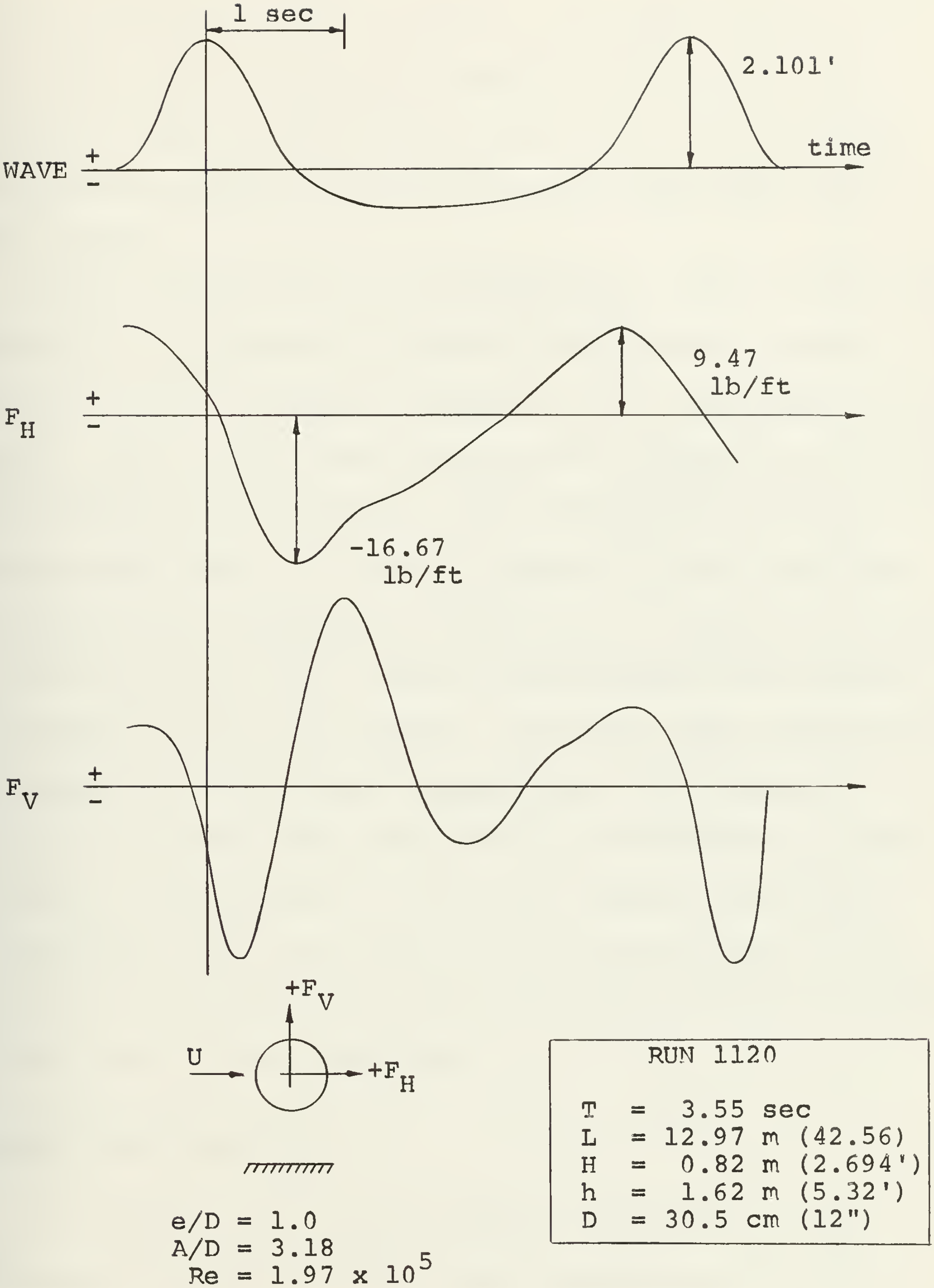


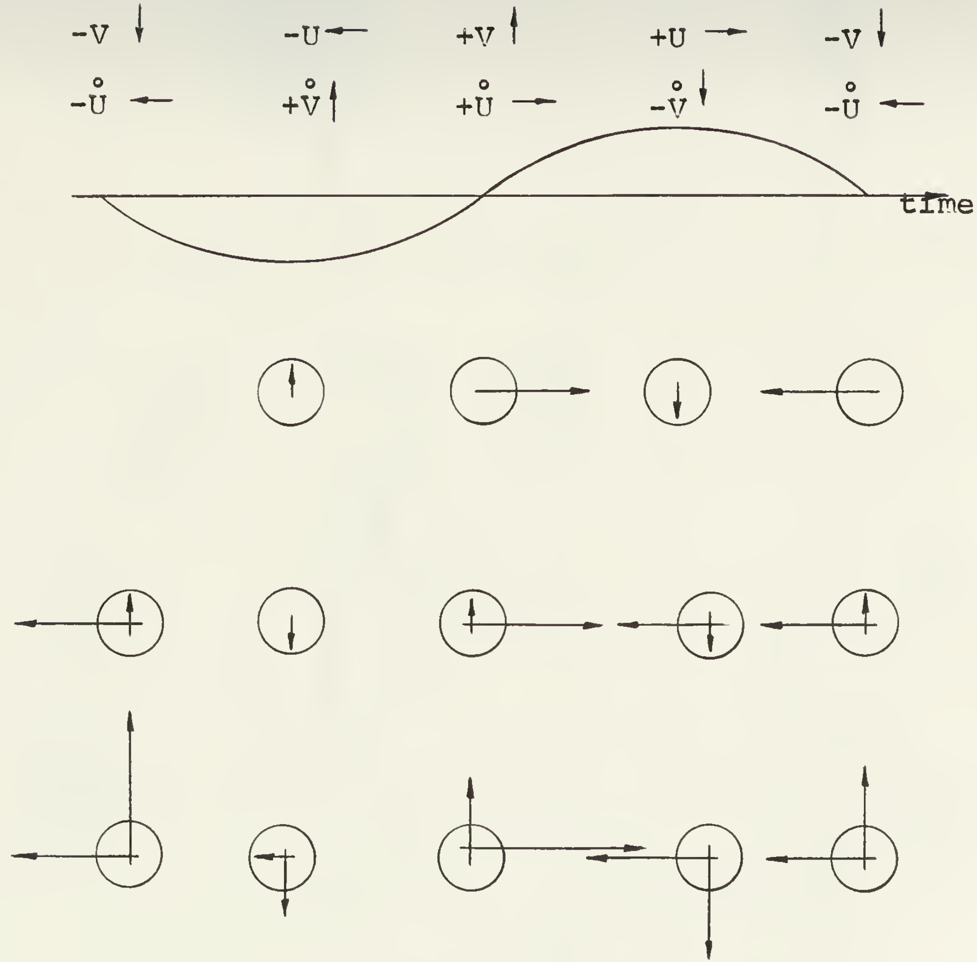
Figure 27. Horizontal and vertical forces, e/D = 1.0.

inertia dominated potential flow. For larger values of A/D up to the limit of this investigation at A/D = 5.0, the vertical forces are characterized by a two- or three-cycle alternating negative and positive force peak within each wave length.

Figure 28 summarizes this discussion. For run 1120 for instance, the alternating positive and negative vertical forces are not adequately predicted by the Airy theory kinematics. Use of the Stream function for prediction of vertical accelerations may explain some discrepancies similar to the previous cases. As shown in Figure 29, the variation in the vertical force for Run 1125 shows a close correlation to the variation of the vertical acceleration predicted by the Stream function wave theory. However, there appears to be a need for further investigation into the problem of periodic vertical forces which are not explained by either inertia or drag effects. It is only suggested here that these forces may be the result of the superposition of inertia and drag effects and the alternating vertical pressure effects due to vortex shedding.

Summary and Conclusion

In summary, one can see from the discussion of the three cases that the maximum forces experienced by the cylinder depend on the proximity of the plane boundary and the kinematics of the flow field. Table 1 is presented as



A/D	RUN
0.75	1110
1.72	1118
3.18	1120

Figure 28. Horizontal and vertical force transition from potential to wake flow, e/D = 1.0.

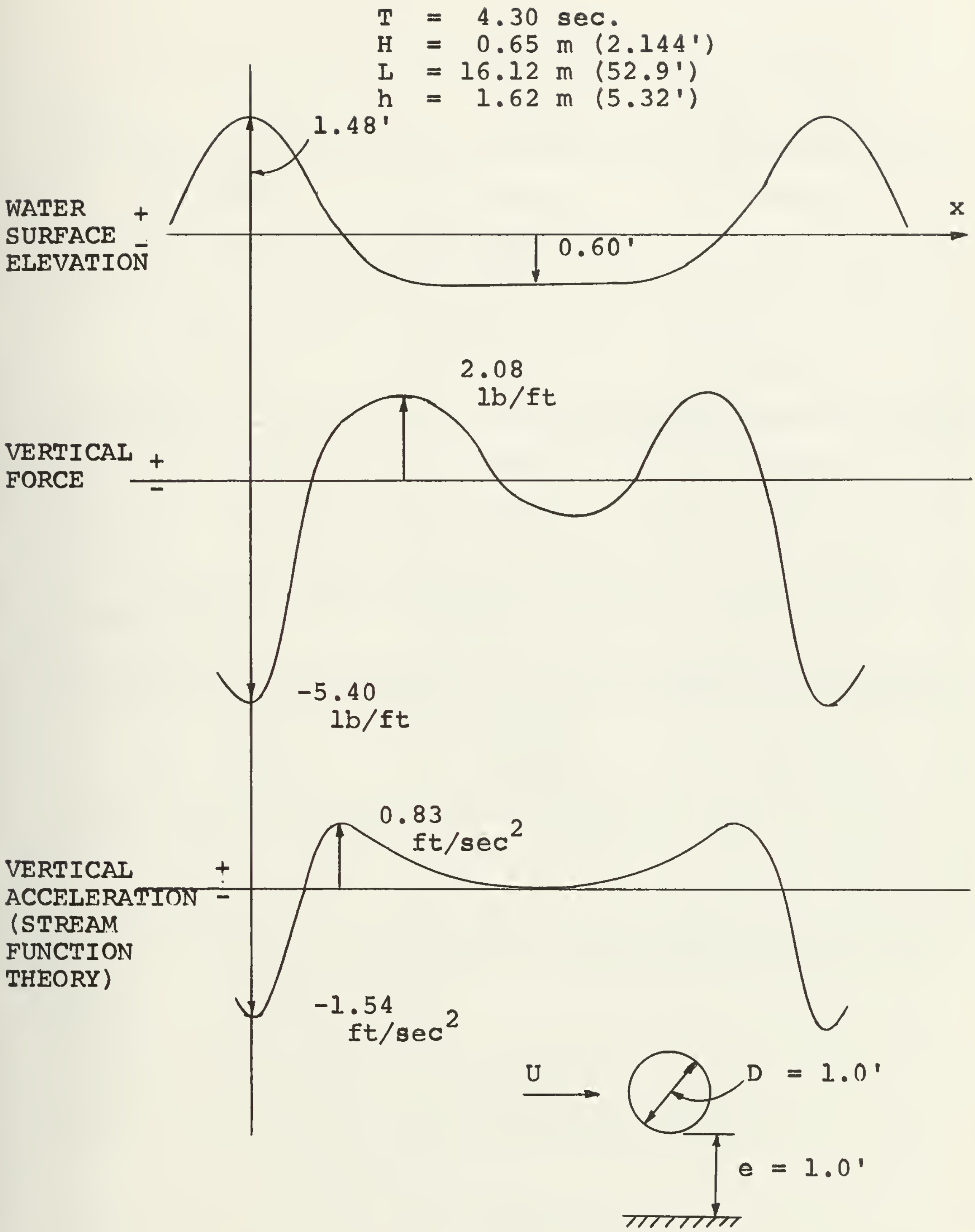


Figure 29. Vertical force on horizontal cylinder correlated with vertical acceleration computed by Stream function theory.

e/D \ A/D	POTENTIAL EFFECT 0.2	POTENTIAL EFFECT 1.0	WAKE EFFECT 3.0 – 6.0
1.0	F_H : Equation 1 F_V : Equation 2 $F_{Hmax} = -F_H$, $\phi = -\pi/2$ $F_{Vmax} = -F_V$, $\phi = 0$ F_M = 2 to 4	F_H : Equation 1 F_V : Equation 2 $F_{Hmax} = -F_H$, $\phi = -\pi/2$ $F_{Vmax} = -F_V$, $\phi = 0$ F_M = 4 to 8	F_H : Equation 3 F_V : Equation 4 $F_{Hmax} = F_H$, $\phi = \pi/2$ $F_{Vmax} = -F_V$, $\phi = 0$ F_M = 1.5 to 3
0.17 TO 0.04	F_H : Equation 1 F_V : Equation 2 $F_{Hmax} = -F_H$, $\phi = -\pi/2$ $F_{Vmax} = -F_V$, $\phi = 0$ F_M = 3 to 4	F_H : Equation 1 F_V : Equation 6 $F_{Hmax} = +F_H$, $\phi = \pi/2$ $F_{Vmax} = -F_V$, $\phi = \pi/6$ F_M = 1.5 to 2	F_H : Equation 5 F_V : Equation 6' $F_{Hmax} = +F_H$, $\phi = \pi/2$ $F_{Vmax} = +F_V$, $\phi = 0$ F_M = 1 to 2
0.0	F_H : Equation 1 F_V : Equation 2 $F_{Hmax} = -F_H$, $\phi = -\pi/2$ $F_{Vmax} = -F_V$, $\phi = 0$ F_M = 8 to 11	F_H : Equation 1 F_V : Equation 6' $F_{Hmax} = -F_H$, $\phi = -\pi/2$ $F_{Vmax} = +F_V$, $\phi = \pi$ F_M = 3.5 to 5	F_H : Equation 5 F_V : Equation 6' $F_{Hmax} = +F_H$, $\phi = \pi/2$ $F_{Vmax} = +F_V$, $\phi = \pi/6$ F_M = 0.5 to 1.5

Equation 1: $F_H = C_I[\rho\pi D^2/4]\ \partial U/\partial t$

Equation 2: $F_V = C_I[\rho\pi D^2/4]\ \partial V/\partial t$

Equation 3: $F_H = C_I[\rho\pi D^2/4]\ \partial U/\partial t + C_D[\rho D/2]\ U|U|\ f(\theta)$

Equation 4: $F_V = C_I[\rho\pi D^2/4]\ \partial V/\partial t + C_D[\rho D/2]\ V|V|\ f(\theta) + \rho\Gamma U$

Equation 5: $F_H = C_I[\rho\pi D^2/4]\ \partial U/\partial t + C_A[\rho\pi D^2/4][U\partial U/\partial x + V\partial U/\partial y] + C_D[\rho D/2]\ U|U|\ f(\theta)$

Equation 6: $F_V = C_I[\rho\pi D^2/4]\ \partial V/\partial t + C_L[\rho D/2]\ U^2$

Equation 6': $F_V = C_I[\rho\pi D^2/4]\ \partial V/\partial t + C_L'[\rho D/2]\ U^2$ where C_L' considers real flow

TABLE 1 Horizontal and Vertical Forces on Horizontal Circular Cylinder Aligned Perpendicular to Flow as Functions of e/D and A/D

a summary of expected effects from potential flow and real flow depending on the location of the cylinder with respect to a plane boundary. The table gives the contribution of the horizontal and vertical forces to the total force on the cylinder in terms of Equations 6 and 7. Contributions due to convective acceleration were included when the convective acceleration was at least ten percent of the local acceleration as calculated by Airy wave theory. It also lists the location of the maximum horizontal and vertical forces with the phase angle measured positive in the direction of the wave advance with $\phi = 0$ at the wave crest. Finally, the expected range of the ratio of maximum forces, F_M, is entered such that

$$F_M = \frac{F_{Hmax}}{F_{Vmax}} .$$

Evaluation of Force Coefficients

In order to evaluate the various force coefficients of inertia, lift, and drag as found in Equations 6 and 7, values of pertinent wave forces were compared with corresponding velocities and accelerations predicted by Airy wave theory. In each case a linear relation was expected and the slope of the line which best visually fit the data yielded the coefficients. Results are given in Table 2.

e/D	RUN	HORIZONTAL FORCE COEFFICIENTS: C_I $-F_H$ vs $\dot{U}_{max}$	C_I $+F_H$ vs $\dot{U}_{max}$	C_D	Range of Re x 10^{-5}	VERTICAL FORCE COEFFICIENTS: C_I $-F_V$ vs $\dot{V}$	C_I $+F_V$ vs $\dot{V}$	C_L $-F_L$ vs U^2_{max}	C_L $+F_V$ vs U^2
0.0	1	2.66							
0.0	6	3.47	2.96	0.93	0.6-1.78		2.37		1.90
0.042	2	2.80		2.00	1.0-1.58	2.41	1.82	-4.29	1.99
0.042	5	2.87	2.66	1.65	0.3-1.81	2.72	2.04	-4.98	2.56
0.042	7	3.13	2.72	1.55	0.6-1.77	2.84	2.13	-5.02	2.25
0.042	13	3.05	2.95	1.61	0.5-1.82	3.00	3.08	-5.26	2.25
0.102	8	2.50		1.67	0.4-1.71	2.44		-3.24	2.41
0.167	9	2.66	2.52	1.90	0.6-1.55	2.64		-2.70	2.17
0.50	10	2.35	2.05	0.88	0.6-1.76	2.32	2.08	-1.04	1.05
1.00	11	2.08	1.80	0.66	1.0-1.66	1.95	1.71		
2.00	16	1.86	1.66			1.92	1.95		

TABLE 2 SUMMARY OF FORCE COEFFICIENTS

<u>Inertia Coefficient</u>

For small values of A/D, horizontal and vertical forces on the cylinder will generally be due to inertia effects and proportional to $\mathring{U}$ or $\mathring{V}$ if convective acceleration effects are ignored. Figures C1 to C9 compare $-F_{Vmax}$ near the wave crest with $\mathring{V}$ evaluated at the force peak where $A/D < 1.5$. The linear relationship between the inertia force and acceleration determine the value of C_I as defined in Equation 2. Nonlinearity and scatter occur for at least two reasons. First, the effect of the plane boundary increases $-F_V$ parabolically with respect to H for potential flow. And second, the value of the vertical acceleration calculated by Airy wave theory does not include convective acceleration effects. The use of the Stream function theory which predicts values of the total acceleration may reduce some of the scatter. See Chapter II.

In Figures C10 to C17, $+F_{Vmax}$ located between the node behind the wave crest and the trough is plotted against $\mathring{V}$ evaluated at the force peak for $A/D < 1.5$. The values of C_I at this position of the wave were generally lower than those values at the wave crest.

In Figures C18 to C28, $-F_{Hmax}$ located near the node behind the wave crest is plotted against $\mathring{U}_{max}$. The maximum value of $\mathring{U}$ was utilized throughout since according to Figure 5, a comparison between Airy and Stream function

theories shows maximum values are nearly equal for both theories.

In Figures C29 to C36, $+F_{Hmax}$ located near the node forward of the wave crest is plotted against $\mathring{U}_{max}$. It is apparent that nonlinearities occurring here may be due to the residual drag forces which increase $+F_H$ parabolically with respect to H. Again, values for C_I evaluated from both the vertical and horizontal forces are plotted against values of e/D in Figures 30 and 31 respectively. From Equation 8 the variation in the coefficient of inertia for a circular cylinder is essentially the variation in the added mass coefficient. This verifies experimental values found by Yamamoto _et al_. (15) and Schiller (12).

Lift Coefficient

It has been shown that one of the effects of a plane boundary on the forces on a horizontal cylinder is to create both positive and negative vertical forces which are proportional to the horizontal velocity squared and thus called lift forces. With these forces separated from the total force and plotted against U^2, the positive and negative values of C_L can be determined from Equation 4.

To separate the negative lift force from the total negative vertical force at the crest of the wave, the assumption that C_I is constant throughout most of the wave is utilized. Since values of U^2 are generally much greater

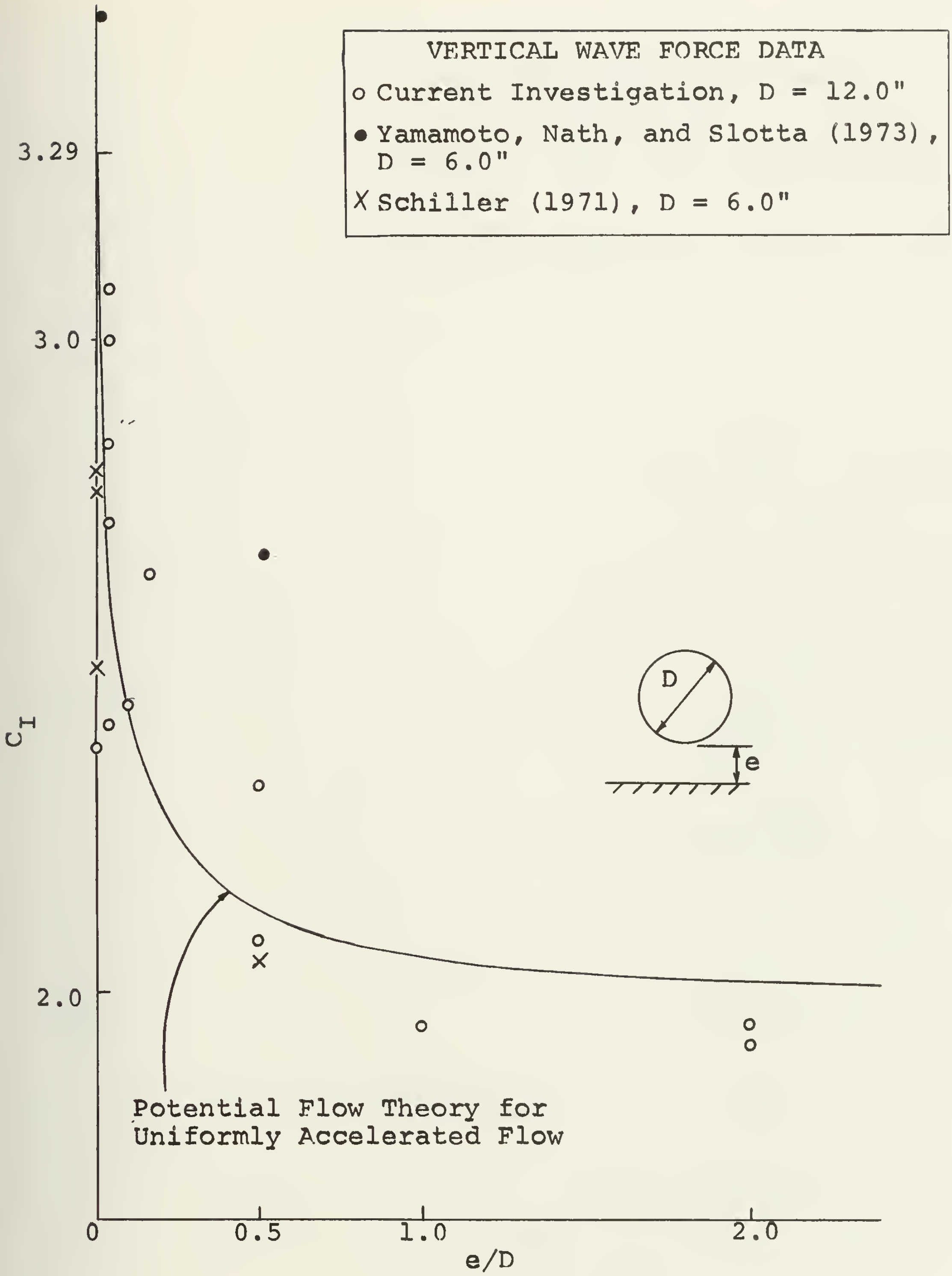


Figure 30. Vertical inertia coefficient for circular cylinder near a plane boundary.

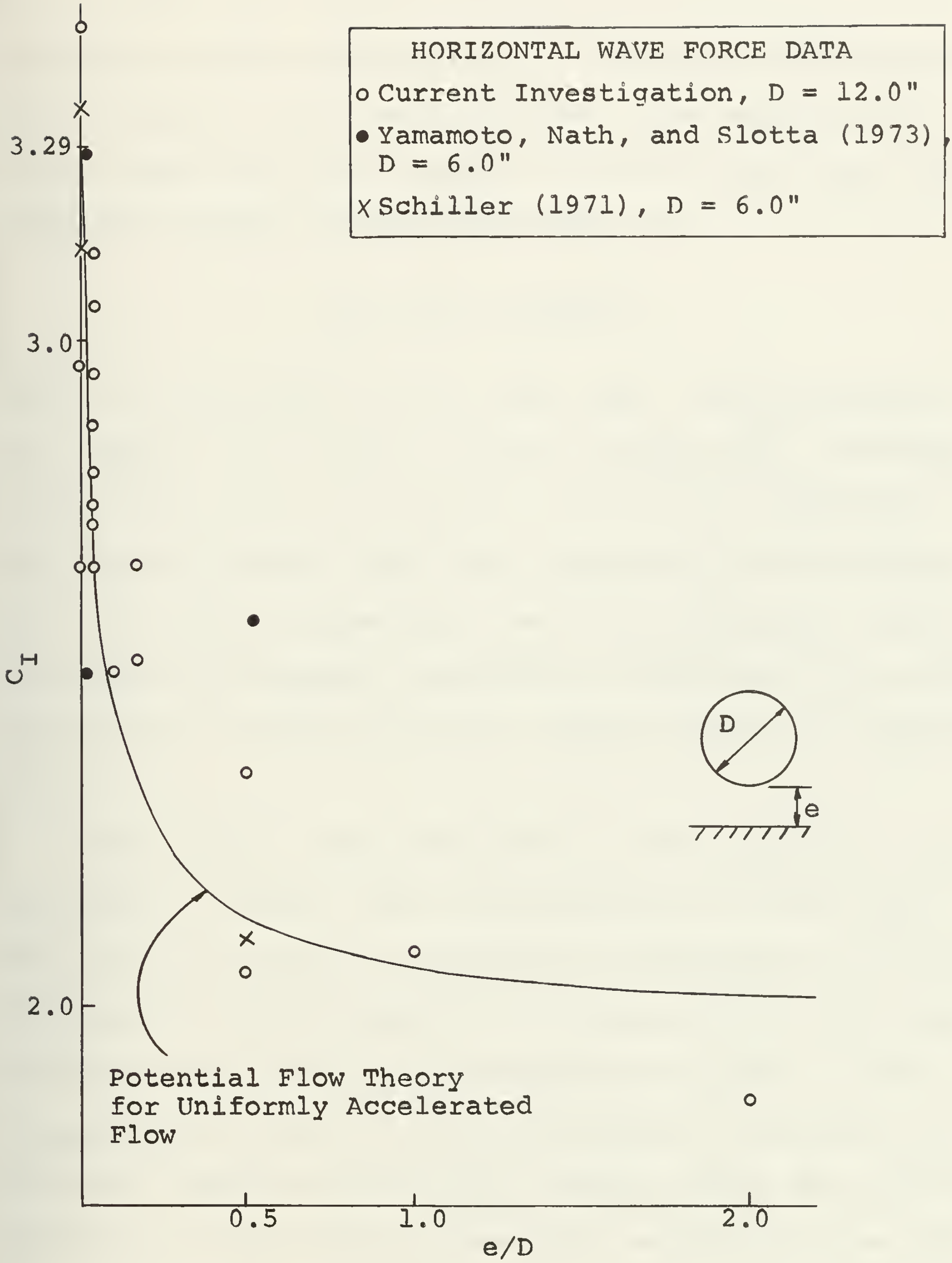


Figure 31. Horizontal inertia coefficient for circular cylinder near a plane boundary.

than values of $\overset{\circ}{V}$, slight variations in values of C_I will negligibly affect values of C_L. Using the maximum value of C_I applicable to the run of interest, the negative lift force equals the total negative vertical force minus the negative vertical acceleration force, or

$$F_L = F_V - C_I \rho \frac{\pi D^2}{4} \overset{\circ}{V}$$

where $\overset{\circ}{V}$ is evaluated at the force peak. Thus separated, the negative lift force is plotted against U^2_{max} evaluated at the wave crest as in Figures C37 to C43. Deviations from the linear relation occur most frequently for runs where $A/D > 1.5$ and are apparently due to the increased wake effect and the consequent generation of positive lift according to the "hydraulic barrier" concept developed in Chapter IV.

The positive lift forces due to flow asymmetries can be readily located. For runs where $e/D = 0$, the $+F_{Vmax}$ near the wave crest is consistently proportional to H^2 and can then be plotted against U^2 evaluated at the force peak to give values for C_L as in Figures C44 to C51. A plot of $+F_{Vmax}$ at the trough of the wave against U^2 evaluated by Airy wave theory exhibited more scatter since the horizontal velocity at the trough is generally less than at the crest for nonlinear waves. For runs where $e/D > 0$, the $+F_{Vmax}$ which begins to appear near the wave crest as A/D increases is plotted against U^2 evaluated at the force peak.

Values of C_L for both potential flow and real flow are plotted against e/D in Figure 32. Experimental values from Yamamoto _et_ _al_. (15) and Schiller (12) are also shown.

Drag Coefficient and Phase Difference Between Drag Force and Ambient Flow

As indicated by Yamamoto _et_ _al_. (15), there exists a definite phase difference between the ambient fluid velocity and the drag force. For laminar flow they showed that the total drag force on a harmonically oscillating circular cylinder is $\pi/4$ out of phase with the cylinder velocity. Therefore there remains a residual drag force on the cylinder when the cylinder reaches maximum acceleration. For turbulent flow, this phase lag will also exist but at a value still to be determined. To illustrate that this phase difference in fact may exist for unsteady flow, Figure 33 compares values of $-F_H$ and wave height for runs 1611-1615. The values of the horizontal forces at various phase angles from the crest show that a linear relationship occurs at $\pi/6$ radians from the crest. Previous evaluations of C_I assumed that a linear relation between force and wave height occurred at the node of the wave for all values of A/D; however the linear relationship at the node is terminated for $A/D > 1.5$. For $A/D > 1.5$ linearity occurs at $\pi/3$ radians from the node. Thus, the assumption of zero drag forces at the node in determining C_I may be in error resulting in the underevaluation of C_I.

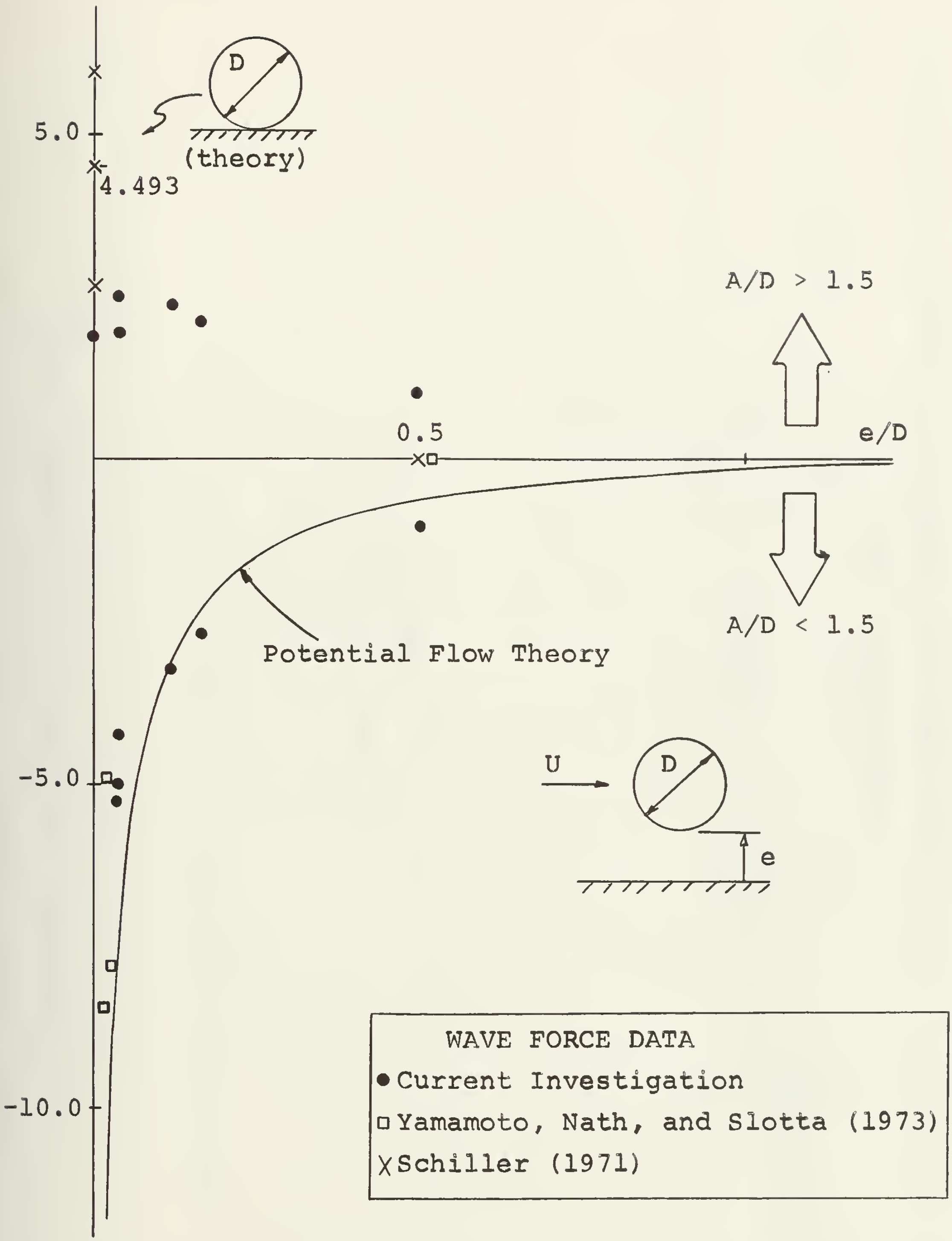


Figure 32. Lift coefficient for circular cylinder near a plane boundary at A/D < 1.5 and A/D > 1.5.

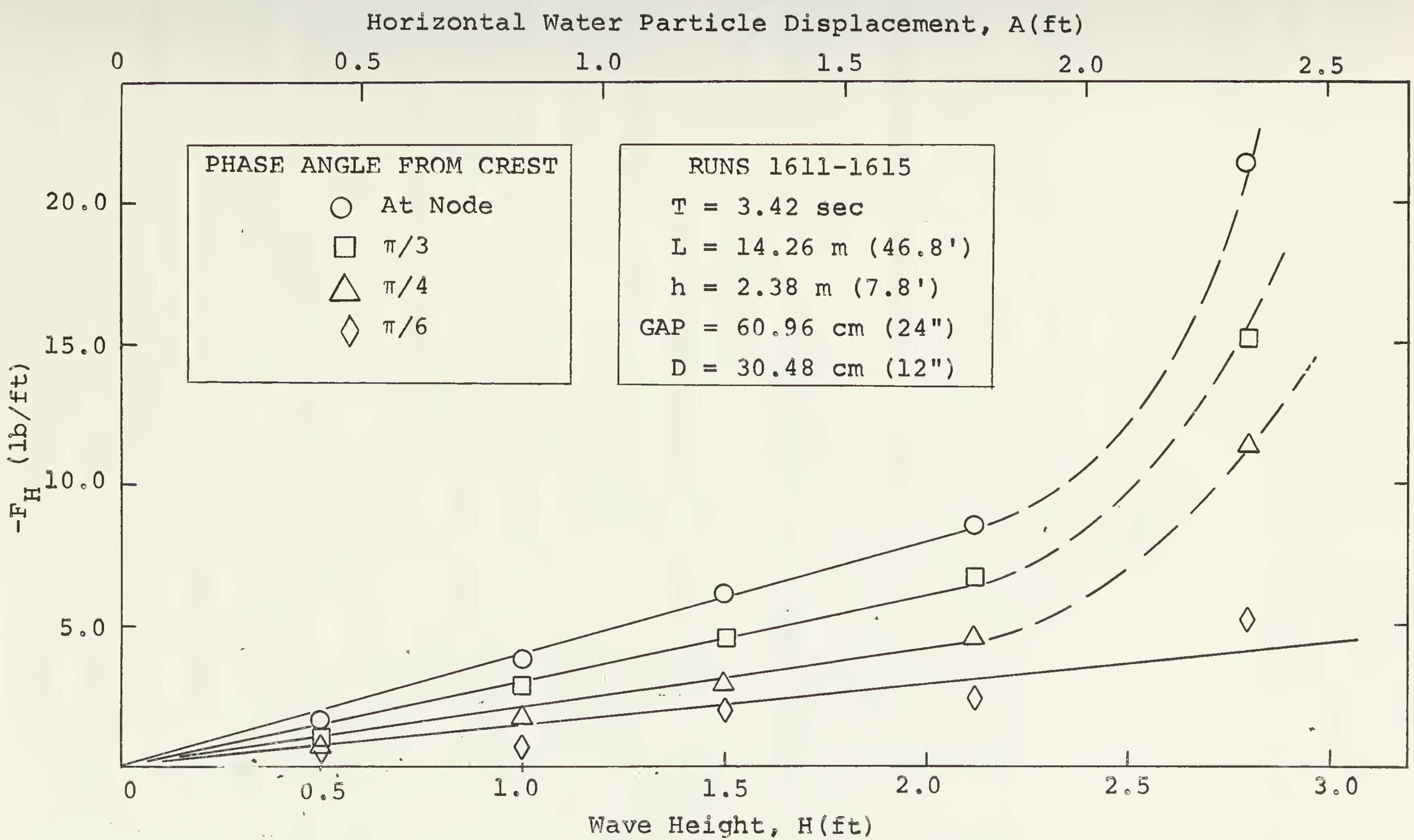


Figure 33. Horizontal force vs wave height and particle displacement for various wave phases.

The value of the positive horizontal force occurring under the wave crest was utilized in evaluating C_D. With this force assumed to be F_D, the coefficient of drag was evaluated according to

$$C_D = \frac{F_D}{\frac{1}{2}\rho D U_{max}^2}$$

Figures C52 to C56 plot F_D against U_{max}^2.

In Figure 34 values of C_D are plotted against e/D at an average value of Reynolds number of 1.3×10^5. Although considerable experimental investigation remains to verify this relationship between C_D and e/D for various values of Reynolds numbers, a comment about the peak value of C_D at e/D = 0.17 is necessary.

In a current investigation by Hafen (17), using flow visualization techniques for steady flow across a horizontal cylinder near a plane boundary, it was shown that the width of the wake behind the cylinder, expressed as the distance between free streamlines, decreased with increasing values of e/D from 0 to 0.9 for a constant subcritical Reynolds number. For e/D > 0.9, the width of the wake increased with increasing values of e/D to the stable wake size in an infinite fluid. The wake width at e/D = 0.9 was less than the wake width in an infinite fluid. In addition, vortex shedding became visible for e/D > 0.25 and subcritical Reynolds numbers. For e/D < 0.25, vortex shedding was suppressed and the wake appeared uniform behind the cylinder.

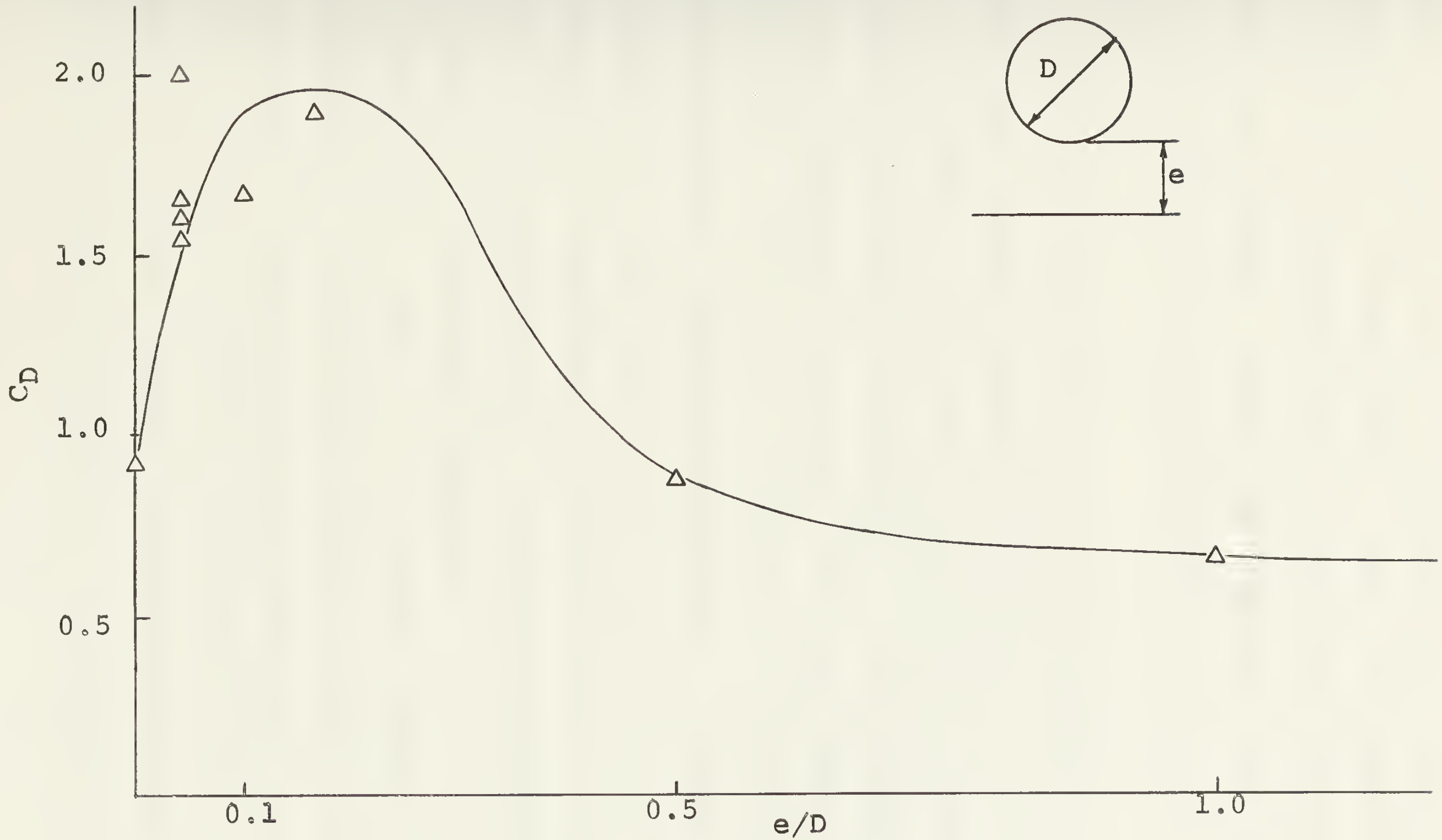


Figure 34. Drag coefficient for cylinder near a plane boundary, Re = 0.3 - 1.8 x 10^5.

In comparing the width of a wake for a circular cylinder at subcritical Reynolds numbers to the drag coefficient, Roshko (16) found that for a given cylinder C_D was inversely proportional to the wake width. Thus, for subcritical Reynolds numbers one would expect an increase in C_D for a decrease in wake width. As with the results from Hafen (17) one would expect an increase in C_D for increasing e/D values of 0 to 0.9.

Considering the characteristics of steady flow past a cylinder near a plane boundary found above, it is possible that the increase in C_D for a cylinder near a plane boundary in unsteady flow may be attributed to the decrease in wake width. In addition, it is noted that the value of C_D for unsteady flow occurs near a value of e/D where vortex shedding begins to appear in steady flow. However, since no evidence of vortex shedding was found, it is difficult to correlate the mechanism of vortex shedding to the termination in the increase of C_D. Additional experimentation and research is definitely required.

Therefore the effect of the plane boundary on the drag coefficient for a horizontal circular cylinder in unsteady flow is that C_D nearly tripled the value of C_D in an infinite fluid as the cylinder approached the plane boundary. Also for the cylinder sealed to the plane boundary, the C_D was 30 percent greater than the C_D in an infinite fluid.

Effect of Water Depth on Force Coefficients

The evaluation of force coefficients utilized in relationships such as the Morison equation depends upon the assumption of a uniform flow field at the structure. If the size of the structure is large compared to a characteristic dimension of the flow, e.g. the wavelength or water depth, then the assumption of uniform flow is in serious error. For a horizontal circular cylinder in a fixed position with respect to a plane boundary, the effect of variations in water depth is to create a nonuniform flow. Thus variations in water depth produced variations in the coefficients of inertia and lift for $A/D < 1.5$. Water depth had no apparent effect on the coefficients of lift and drag for $A/D > 1.5$.

Specifically, referring to Table 2, values of water depth with respect to cylinder diameter, expressed as h/D, were 2.35, 3.14, 5.32, and 7.8 for $e/D = 0.042$ (runs 2, 5, 7 and 13, respectively). Theoretically, for $e/D = 0.042$ and a uniformly accelerated flow, $C_I \cong 2.8$. Values of C_I from vertical forces for this value of e/D varied from $C_I = 1.82$ to $C_I = 3.08$ as h/D increased from 2.35 to 7.8. Values of C_I from horizontal forces varied from $C_I = 2.8$ to $C_I = 3.05$ as h/D increased from 2.35 to 7.8. Theoretically, for $e/D = 0.042$ and a uniform flow, $C_L \cong -7.0$. As h/D increased from $h/D = 2.35$ to $h/D = 7.8$, for $A/D < 1.5$, C_L varied from $C_L = -4.29$ to $C_L = -5.26$. Therefore as water depth becomes

more shallow, the assumption of uniform flow becomes less valid for evaluation of both vertical and horizontal C_I and C_L where $A/D < 1.5$. However, the horizontal C_I is less affected by changes in water depth than the vertical C_I. It is noted that for $h/D = 7.8$, values of both vertical and horizontal C_I are approximately equal and close to predicted potential flow values. Consequently at $h/D = 7.8$ the effect of water depth on force coefficients appears negligible.

In conclusion, the values of C_I and C_L as predicted by potential flow theory are conservative when applied in shallow water depths were $h/D < 7.8$. Also, variations in water depth affected vertical inertia coefficients more than horizontal inertia coefficients. Variations in water depth did not appreciably affect values of C_L and C_D for $A/D >$ 1.5.

V. SUMMARY AND CONCLUSIONS

From the experimental results, the following summary is made and conclusions drawn:

1. The hydrodynamic force coefficients of inertia, lift and drag for a horizontal circular cylinder varied according to the proximity of the plane boundary, expressed as e/D, the relative horizontal particle displacement, expressed as A/D, and the relative water depth, expressed as h/D.

Effects of Particle Displacement

2. For $0 < A/D < 1.5$ the flow around the cylinder was that of potential flow to which potential flow theory is applicable. For $A/D > 1.5$, wake effects become significant and theoretical results from potential flow theory need to be modified.

Effects of Plane Boundary

3. Values of C_I from horizontal forces increased from $C_I = 1.86$ to $C_I = 3.47$ as the cylinder approached the plane boundary.

4. Values of C_I from vertical forces increased from $C_I = 1.92$ to $C_I = 2.37$ as the cylinder approached the plane boundary.

5. The inertia coefficients obtained from the horizontal force data were nearly equal, but generally greater than those obtained from vertical forces. The experimental values of C_I agreed well with theoretical values for a uniformly accelerated flow except for shallow water depths as noted below.

6. For $A/D < 1.5$ and $e/D > 0$, values of C_L varied from $C_L = 0$ to $C_L = -5.3$ as the cylinder approached the plane boundary. Experimental values agreed well with theoretical values for uniform flow except for shallow water depths as noted below.

7. For $1.5 < A/D < 5.0$ and $e/D = 0$, $C_L = 1.9$.

8. For $1.5 < A/D < 5.7$ and $e/D > 0$, C_L increased from $C_L = 0$ to $C_L = 2.6$ as the cylinder approached the plane boundary.

9. The horizontal cylinder experienced alternating positive and negative vertical forces, which at times were of the same magnitude as horizontal forces, when $1.5 < A/D < 5.7$ and $0 < e/D < 1.0$. These lift forces occurred at twice the wave frequency and may constitute a possible failure mode for submarine pipelines.

10. For an average Reynolds number of 1.3×10^5, as the cylinder approached the plane boundary, C_D increased from $C_D = 0.66$ at $e/D = 1.0$ to $C_D = 1.9$ at $e/D = 0.17$, and then decreased to $C_D = 0.93$ at $e/D = 0$.

Effect of Water Depth

11. Relative variations in water depth, expressed as h/D, produced variations in C_I and C_L.

12. As h/D varied from h/D = 2.35 to h/D = 7.8, C_I evaluated from vertical forces at e/D = 0.042 varied from $C_I = 1.8$ to $C_I = 3.08$.

13. As h/D varied from h/D = 2.35 to h/D = 7.8, C_I evaluated from horizontal forces at e/D = 0.042 varied from $C_I = 2.8$ to $C_I = 3.05$. Variations in the horizontal force coefficient were less than the vertical.

14. For A/D < 1.5 and e/D = 0.042, as h/D varied from h/D = 2.35 to h/D = 7.8, C_L varied from $C_L = -4.29$ to $C_L = -5.26$.

15. For A/D > 1.5, variations in relative water depth had no apparent effect on C_L or C_D.

Recommendations for Further Research

16. A phase difference may exist between the velocity of the ambient flow around a cylinder and the drag force. This suggests that values of C_I evaluated when the drag force was assumed to be zero may be in error.

17. Further research was found necessary to determine and quantify the effects of vortex shedding on horizontal circular cylinders in oscillatory flows and to verify the relationship between C_D and e/D for different Reynolds numbers and extended ranges of A/D.

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APPENDICES

APPENDIX A

This appendix contains a computer routine for calculating various wave parameters for experimental runs by the Airy wave theory.

Nomenclature of results is as follows:

HC = Wave height above cylinder (ft)

HI = Wave height forward of cylinder (ft)

T = Wave period (sec)

LC = Wave length calculated by Airy wave theory (ft)

L = Observed wave length (ft)

H = Water depth (ft)

E = Gap between cylinder and plane boundary (in)

APPENDIX A

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      PROGRAM WAVES1
C     J.C. WRIGHT, GRAF302
C     THIS PROGRAM CALCULATES WAVE PARAMETERS AND CERTAIN
C     DIMENSIONLESS RATIOS UTILIZING AIRY WAVE THEORY
C     BASED ON DATA FROM SEA-GRANT RESEARCH PROJECT COMPLETED
C     SUMMER 1974 AT WAVE RESEARCH FACILITY, OSU
C
      REAL Z,ALPHA,BETA,EXA,EXB,EXC,EXD,EXE,U,V,UA,VA,HDELTA,
     1 VDELTA,PMAX,HRE,VRE,FR,CX,CY,CTAX,CTAY,VERT,GI
     2 ,NU,RHO,PI,LC,L
C
      INTEGER REF,RUN
      DIMENSION REF(201),RUN(201),HC(201),HI(201),T(201),
     1 LC(201),L(201),H(201),E(201),Z(201),ALPHA(201),BETA(201),
     2 EXA(201),EXB(201),EXC(201), EXD(201),EXE(201),U(201),
     3 V(201),UA(201),VA(201),HDELTA(201),VDELTA(201),PMAX(201),
     4 HRE(201),VRE(201),FR(201),CX(201),CY(201),RA(201),
     5 RB(201),RC(201),RD(201),RE(201),RF(201),RG(201),RH(201),
     6 GI(201),CTAX(201),CTAY(201),VERT(201)
C
      D=TTYIN(4H D= )
      CL=TTYIN(4H CL= )
      CI=TTYIN(4H CI= )
      RHO=1.94
      NU=1.42E-5
      PI=3.14159
C
      WRITE(61,11)
C
      DO 10 I=1,201
C     READ DATA BANK
C
      READ(40,5) REF(I),RUN(I),HC(I),HI(I),T(I) ,
     1 LC(I),L(I),H(I),E(I)
      WRITE(61,12) REF(I),RUN(I),HC(I),HI(I),T(I),LC(I)
     1 ,L(I),H(I),E(I)
    5 FORMAT(I3,I5,3F6.0,2F7.0,2F6.0)
      Z(I)=-H(I)+(D/2.)+(E(I)/12.)
      ALPHA(I)=2.*PI*(Z(I)+H(I))/LC(I)
      BETA(I)=2.*PI*H(I)/LC(I)
      EXA(I)=EXP(ALPHA(I))+EXP(-ALPHA(I))
      EXB(I)=EXP(ALPHA(I))-EXP(-ALPHA(I))
      EXC(I)=EXP(BETA(I))+EXP(-BETA(I))
      EXD(I)=EXP(BETA(I))-EXP(-BETA(I))
      EXE(I)=EXP(2.*ALPHA(I))-EXP(-2.*ALPHA(I))
C
C     VELOCITIES AND TEMPORAL ACCELERATIONS
C
      U(I)=16.1*HC(I)*T(I)*EXA(I)/(EXC(I)*LC(I))
      V(I)=16.1*HC(I)*T(I)*EXB(I)/(EXC(I)*LC(I))
      UA(I)=32.2*PI*HC(I)*EXA(I)/(EXC(I)*LC(I))
      VA(I)=32.2*PI*HC(I)*EXB(I)/(EXC(I)*LC(I))
C
C     PARTICLE DISPLACEMENT AND DYNAMIC PRESSURE
C
      HDELTA(I)=HC(I)*EXA(I)/EXC(I)

      VDELTA(I)=HC(I)*EXB(I)/EXA(I)
      PMAX(I)=(16.1*RHO*HC(I)*EXA(I)/EXC(I))-32.2*RHO*Z(I)
C
C     REYNOLDS NO. AND FROUDE NO.
C
      HRE(I)=U(I)*D/NU
      VRE(I)=V(I)*D/NU
      FR(I)=U(I)/SQRT(32.2*ABS(Z(I)))
C
C     CONVECTIVE ACCELERATIONS IN POTENTIAL FLOW
C
      CX(I)=1036.84*PI*HC(I)**2*T(I)**2/(LC(I)**3*EXC(I)**2)
      CY(I)=518.42*PI*HC(I)**2*T(I)**2*EXE(I)/(LC(I)**3*
     1 EXC(I)**2)
C
C     DIMENSIONLESS RATIOS
C
      RA(I)=PI*D/LC(I)
      RB(I)=H(I)/LC(I)
      RC(I)=HC(I)/HI(I)
      RD(I)=L(I)/LC(I)
      RE(I)=HC(I)/T(I)**2
      RF(I)=H(I)/D
      RG(I)=HC(I)/LC(I)
      RH(I)=HC(I)/D
C
C     CONVECTIVE/TEMPORAL ACCELERATION RATIO
```

```
      CTAX(I)=ABS(CX(I))/ABS(UA(I))
      CTAY(I)=ABS(CY(I))/ABS(VA(I))
C
C     VELCCITY-SQUARED/TEMPORAL ACCEL. RATIO AND
C     GRAVITY/INERTIA RATIO
C
      VERT(I)=ABS(CL*U(I)**2)/ABS(2.*CI*D**2*UA(I))
      GI(I)=FR(I)/HRE(I)
C
   10 CCNTINUE
C
      WRITE(61,14)
      DO 100 I=1,201
  100 WRITE(61,20) RUN(I),U(I),UA(I),CX(I),HDELTA(I),HRE(I)
      WRITE(61,15)
      DO 101 I=1,201
  101 WRITE(61,21) RUN(I),V(I),VA(I),CY(I),VDELTA(I),VRE(I)
      WRITE(61,16)
      DO 102 I=1,201
  102 WRITE(61,22) RUN(I),CTAX(I),CTAY(I),VERT(I)
      WRITE(61,17)
      DC 103 I=1,201
  103 WRITE(61,23) RUN(I),PMAX(I),FR(I),GI(I)
      WRITE(61,18)
      DC 104 I=1,201
  104 WRITE(61,24) RUN(I),RC(I),RC(I),RA(I)
      WRITE(61,19)
      DC 105 I=1,201
  105 WRITE(61,25) RUN(I),RF(I),RH(I),RE(I),RB(I),RG(I)
C
   14 FORMAT(1H1,1X,≠RUN≠,5X,≠U≠,7X,≠U-DOT≠,4X,≠CCNVECTIVE ACCEL≠,
     1 3X,≠HORIZONTAL≠,5X,≠REYNCLDS NO≠,/,44X,≠DISPLACEMENT≠,//)
   15 FORMAT(1H1,1X,≠RUN≠,5X,≠V≠,7X,≠V-DOT≠,4X,≠CCNVECTIVE ACCEL≠,
     1 3X,≠VERTICAL≠,9X,≠REYNCLDS NO≠,/,44X,≠DISPLACEMENT≠,//)
   16 FORMAT(1H1,1X,≠RUN≠,5X,≠CNVECTVE-TEMPORAL RATIO≠,
     1 5X,≠LIFT-INERTIA RATIO≠,/,18X,≠X-DIR≠,6X,≠Y-DIR≠,
     2 19X,≠X-DIR≠,//)
   17 FORMAT(1H1,1X,≠RUN≠,5X,≠PMAX≠,8X,≠FROUDE NO≠,7X,
     1 ≠FR-REYNOLDS RATIO≠,//)
   18 FORMAT(1H1,1X,≠RUN≠,5X,≠HI/HC≠,4X,≠L/LC≠,4X,≠PI*D/LC≠,//)
   19 FORMAT(1H1,1X,≠RUN≠,5X,≠H/D≠,4X,≠HC/D≠,5X,
     1 ≠HC/T**2≠,4X,≠H/LC≠,4X,≠HC/LC≠,//)
   20 FORMAT(I6,2F9.4,F14.4,F17.4,1PE17.4)
   21 FORMAT(I6,2F9.4,F14.4,F17.4,1PE17.4)
   22 FORMAT(I6,F13.6,F11.6,F25.6)
   23 FORMAT(I6,F11.4,1PE14.4,1PE21.4)
   24 FORMAT(I6,F10.4,F8.4,F3.4)
   25 FORMAT(I6,2F8.4,F11.4,2F9.4)
   12 FORMAT(I4,I5,3F6.3,2F7.2,2F6.2)
   11 FORMAT(1H1,≠REF≠,2X,≠RUN≠,2X,≠HC≠,4X,≠HI≠,5X,
     1 ≠T≠,6X,≠LC≠,5X,≠L≠,5X,≠H≠,6X,≠E≠,//)
      CALL EXIT
      END
```

RUN	HC	HI	T	LC	L	H	E
107	.303	.306	1.414	9.40	8.80	2.35	0
108	.444	.470	1.414	9.40	8.87	2.35	0
109	.626	.639	1.414	9.40	8.98	2.35	0
112	.338	.347	1.338	13.70	13.02	2.35	0
113	.501	.522	1.838	13.70	13.26	2.35	0
114	.633	.684	1.838	13.70	13.01	2.35	0
117	.579	.522	2.370	18.80	18.80	2.35	0
118	.778	.708	2.370	18.80	18.80	2.35	0
119	.934	.843	2.370	18.80	18.90	2.35	0
122	.465	.486	2.920	24.00	23.20	2.35	0
123	.663	.681	2.920	24.00	22.00	2.35	0
124	.981	1.021	2.920	24.00	23.40	2.35	0
201	.095	.104	.960	4.70	6.30	2.35	.50
202	.189	.193	.960	4.70	6.70	2.35	.50
203	.291	.347	.960	4.70	7.00	2.35	.50
205	.217	.223	1.414	9.40	8.60	2.35	.50
207	.302	.330	1.414	9.40	8.80	2.35	.50
208	.444	.472	1.414	9.40	8.90	2.35	.50
209	.636	.653	1.414	9.40	9.00	2.35	.50
210	.779	.838	1.414	9.40	9.00	2.35	.50
211	.281	.293	1.838	13.70	12.10	2.35	.50
212	.342	.351	1.838	13.70	12.00	2.35	.50
213	.532	.507	1.839	13.70	12.10	2.35	.50
214	.721	.660	1.838	13.70	12.60	2.35	.50
215	.809	.772	1.838	13.70	12.80	2.35	.50
216	.313	.250	2.370	18.80	17.70	2.35	.50
217	.599	.556	2.370	18.80	18.20	2.35	.50
218	.754	.701	2.370	18.80	19.80	2.35	.50
219	.889	.847	2.370	18.80	19.50	2.35	.50
220	1.143	1.058	2.370	18.80	19.70	2.35	.50
221	.245	.169	2.920	24.00	21.40	2.35	.50
222	.493	.486	2.920	24.00	23.20	2.35	.50
223	.653	.702	2.920	24.00	22.00	2.35	.50
224	.956	.972	2.920	24.00	22.60	2.35	.50
225	1.221	1.193	2.920	24.00	22.90	2.35	.50
226	.245	.222	5.500	47.30	44.30	2.35	.50
227	.476	.444	5.500	47.30	48.70	2.35	.50
228	.830	.758	5.500	47.30	44.30	2.35	.50
229	1.088	.944	5.500	47.30	45.80	2.35	.50
230	1.252	1.151	5.500	47.30	47.00	2.35	.50
301	.135	.194	.960	4.70	4.50	2.35	2.00
302	.272	.278	.960	4.70	4.50	2.35	2.00
303	.381	.454	.960	4.70	4.70	2.35	2.00
306	.204	.206	1.414	9.40	9.10	2.35	2.00
307	.283	.278	1.414	9.40	8.70	2.35	2.00
308	.404	.417	1.414	9.40	8.90	2.35	2.00
309	.579	.604	1.414	9.40	9.10	2.35	2.00
310	.768	.814	1.414	9.40	9.20	2.35	2.00
311	.242	.264	1.838	13.70	12.80	2.35	2.00
312	.327	.351	1.838	13.70	13.10	2.35	2.00
313	.454	.514	1.838	13.70	12.80	2.35	2.00
314	.653	.694	1.838	13.70	12.80	2.35	2.00
315	.776	.819	1.838	13.70	13.10	2.35	2.00
316	.296	.250	2.370	18.80	18.80	2.35	2.00
317	.571	.517	2.370	18.80	19.10	2.35	2.00
318	.680	.632	2.370	18.80	18.60	2.35	2.00
319	.912	.797	2.370	18.80	19.70	2.35	2.00
320	1.051	.972	2.370	18.80	16.50	2.35	2.00
321	.286	.253	2.920	24.00	22.30	2.35	2.00
322	.476	.491	2.920	24.00	22.30	2.35	2.00
323	.646	.667	2.920	24.00	22.80	2.35	2.00
324	.952	.931	2.920	24.00	23.00	2.35	2.00
325	1.091	1.153	2.920	24.00	22.30	2.35	2.00
326	.247	.239	5.500	47.30	48.10	2.35	2.00
327	.476	.449	5.500	47.30	45.50	2.35	2.00
328	.694	.632	5.500	47.30	46.30	2.35	2.00
329	1.088	1.028	5.500	47.30	45.20	2.35	2.00
330	1.170	1.039	5.500	47.30	46.60	2.35	2.00
407	.289	.264	1.414	9.40	8.70	2.35	6.00
408	.409	.393	1.414	9.40	9.10	2.35	6.00
409	.605	.639	1.414	9.40	9.00	2.35	6.00
411	.231	.250	1.838	13.70	13.30	2.35	5.00
412	.327	.361	1.838	13.70	12.90	2.35	6.00
413	.509	.491	1.838	13.70	12.90	2.35	6.00
414	.667	.701	1.838	13.70	13.40	2.35	6.00
417	.599	.522	2.370	18.90	19.10	2.35	6.00
418	.701	.597	2.370	18.80	18.60	2.35	6.00
4180	.776	.744	2.370	18.80	19.90	2.35	6.00
419	.838	.833	2.370	18.90	18.40	2.35	6.00
422	.522	.453	2.920	24.00	22.00	2.35	6.00
423	.680	.646	2.920	24.00	22.50	2.35	6.00

RUN	HC	HI	T	LC	L	H	E
424	.980	.962	2.920	24.00	23.20	2.35	6.00
501	.302	.319	1.061	5.75	5.60	3.14	.50
502	.467	.444	1.061	5.75	5.76	3.14	.50
503	.517	.542	1.061	5.75	5.80	3.14	.50
504	.566	.583	1.061	5.75	5.90	3.14	.50
506	.189	.236	1.633	12.53	11.70	3.14	.50
507	.323	.347	1.633	12.53	11.80	3.14	.50
508	.485	.547	1.633	12.53	11.80	3.14	.50
509	.781	.861	1.633	12.53	11.80	3.14	.50
510	.952	.986	1.633	12.53	12.10	3.14	.50
511	.299	.295	2.172	18.86	18.60	3.14	.50
512	.440	.389	2.172	18.86	18.10	3.14	.50
513	.585	.561	2.172	18.85	18.30	3.14	.50
514	.825	.750	2.172	18.86	18.00	3.14	.50
515	1.072	1.011	2.172	18.86	18.65	3.14	.50
516	.327	.330	2.506	22.59	21.40	3.14	.50
517	.476	.514	2.506	22.59	22.10	3.14	.50
518	.694	.800	2.506	22.59	21.80	3.14	.50
519	.939	1.000	2.506	22.59	22.50	3.14	.50
520	1.306	1.544	2.506	22.59	22.50	3.14	.50
521	.272	.278	3.304	31.20	28.70	3.14	.50
522	.476	.486	3.304	31.20	28.30	3.14	.50
523	.646	.674	3.304	31.20	27.90	3.14	.50
524	1.058	1.056	3.304	31.20	30.00	3.14	.50
525	1.497	1.500	3.304	31.20	30.60	3.14	.50
526	.259	.272	6.341	63.00	58.30	3.14	.50
527	.449	.444	6.341	63.00	58.70	3.14	.50
528	.735	.736	6.341	63.00	62.90	3.14	.50
529	.898	.861	6.341	63.00	62.90	3.14	.50
530	1.660	1.516	6.341	63.00	62.90	3.14	.50
601	.202	.194	1.440	10.58	10.00	5.32	0
602	.340	.344	1.440	10.58	10.30	5.32	0
603	.476	.486	1.440	10.58	10.40	5.32	0
604	.639	.639	1.440	10.58	10.40	5.32	0
605	1.010	1.003	1.440	10.58	10.70	5.32	0
606	.327	.337	2.130	21.28	20.40	5.32	0
607	.481	.486	2.130	21.28	20.40	5.32	0
608	.626	.632	2.130	21.28	20.40	5.32	0
609	.935	.982	2.130	21.28	20.40	5.32	0
610	1.578	1.656	2.130	21.28	20.20	5.32	0
611	.313	.302	2.820	31.80	29.40	5.32	0
612	.633	.674	2.820	31.80	29.30	5.32	0
613	1.020	1.042	2.820	31.80	30.10	5.32	0
614	1.469	1.417	2.820	31.80	31.30	5.32	0
615	1.959	1.944	2.820	31.80	32.30	5.32	0
616	.544	.496	3.550	42.56	39.80	5.32	0
617	.993	.958	3.550	42.56	40.60	5.32	0
618	1.497	1.389	3.550	42.56	41.10	5.32	0
619	2.144	2.000	3.550	42.56	41.10	5.32	0
620	2.776	2.889	3.550	42.56	42.90	5.32	0
621	.449	.486	4.300	52.90	51.90	5.32	0
622	.875	.958	4.300	52.90	52.50	5.32	0
623	1.333	1.375	4.300	52.90	43.80	5.32	0
624	1.741	1.842	4.300	52.90	46.80	5.32	0
625	2.101	2.246	4.300	52.90	51.90	5.32	0
626	.426	.444	6.200	78.84	71.80	5.32	0
627	.762	.722	6.200	78.84	80.70	5.32	0
628	1.131	1.072	6.200	78.84	74.90	5.32	0
629	1.724	1.600	6.200	78.84	73.30	5.32	0
630	2.177	1.965	6.200	78.84	74.60	5.32	0
701	.231	.222	1.440	10.58	10.20	5.32	.50
702	.367	.295	1.440	10.58	9.90	5.32	.50
7020	.327	.347	1.440	10.58	10.10	5.32	.50
703	.471	.491	1.440	10.58	10.40	5.32	.50
704	.626	.597	1.440	10.58	10.30	5.32	.50
705	1.048	.958	1.440	10.58	10.80	5.32	.50
706	.323	.317	2.130	21.28	20.10	5.32	.50
707	.440	.431	2.130	21.28	20.90	5.32	.50
708	.606	.625	2.130	21.28	20.10	5.32	.50
709	.925	.931	2.130	21.28	20.80	5.32	.50
710	1.578	1.600	2.130	21.28	20.90	5.32	.50
711	.286	.295	2.820	31.80	31.30	5.32	.50
712	.680	.687	2.820	31.80	31.00	5.32	.50
713	1.061	1.081	2.820	31.80	30.00	5.32	.50
714	1.442	1.460	2.820	31.80	32.60	5.32	.50
715	1.905	1.944	2.820	31.80	29.80	5.32	.50
716	.544	.514	3.550	42.56	39.00	5.32	.50
717	.997	.944	3.550	42.56	41.10	5.32	.50
718	1.401	1.375	3.550	42.56	38.50	5.32	.50
719	2.150	2.000	3.550	42.56	38.80	5.32	.50
720	2.776	2.639	3.550	42.56	41.00	5.32	.50
721	.476	.491	4.300	52.90	43.80	5.32	.50
722	.912	.954	4.300	52.90	43.60	5.32	.50
723	1.279	1.464	4.300	52.90	52.50	5.32	.50

RUN	HC	HI	T	LC	L	H	E
724	1.878	1.993	4.300	52.90	50.80	5.32	.50
725	2.316	2.278	4.300	52.90	51.90	5.32	.50
726	.354	.389	6.200	78.84	82.00	5.32	.50
727	.721	.698	6.200	78.84	76.50	5.32	.50
728	1.185	1.123	6.200	78.84	79.30	5.32	.50
729	1.769	1.639	6.200	78.84	76.50	5.32	.50
730	2.122	1.985	6.200	78.84	74.20	5.32	.50
801	.202	.205	1.440	10.59	9.90	5.32	1.25
802	.350	.351	1.440	10.58	10.10	5.32	1.25
803	.498	.485	1.440	10.49	10.30	5.32	1.25
804	.639	.611	1.440	10.58	10.40	5.32	1.25
805	1.051	1.028	1.440	10.58	10.40	5.32	1.25
806	.310	.333	2.130	21.28	20.00	5.32	1.25
807	.458	.475	2.130	21.28	20.10	5.32	1.25
808	.633	.633	2.130	21.28	20.50	5.32	1.25
809	.962	.971	2.130	21.28	20.20	5.32	1.25
810	1.578	1.593	2.130	21.28	20.90	5.32	1.25
811	.313	.319	2.820	31.80	31.50	5.32	1.25
812	.700	.674	2.820	31.80	30.10	5.32	1.25
813	1.034	1.042	2.820	31.80	31.00	5.32	1.25
814	1.524	1.528	2.820	31.80	31.20	5.32	1.25
815	1.959	2.071	2.820	31.80	32.60	5.32	1.25
816	.558	.491	3.550	42.55	42.00	5.32	1.25
817	.956	.931	3.550	42.56	37.50	5.32	1.25
819	2.095	2.028	3.550	42.56	38.50	5.32	1.25
820	2.776	2.667	3.550	42.56	41.10	5.32	1.25
821	.476	.486	4.300	52.90	47.50	5.32	1.25
822	.952	.982	4.300	52.90	49.20	5.32	1.25
823	1.442	1.460	4.300	52.90	51.90	5.32	1.25
824	1.850	1.903	4.300	52.90	48.60	5.32	1.25
825	2.231	2.222	4.300	52.90	50.20	5.32	1.25
826	.431	.444	6.200	78.84	73.10	5.32	1.25
827	.707	.708	6.200	78.84	74.90	5.32	1.25
828	1.116	1.095	6.200	78.84	82.00	5.32	1.25
829	1.697	1.572	6.200	78.84	74.80	5.32	1.25
830	2.340	2.128	6.200	78.84	71.40	5.32	1.25

RUN	HC	HI	T	LC	L	H	E
902	.350	.347	1.440	10.58	10.00	5.32	2.00
903	.498	.486	1.440	10.58	10.10	5.32	2.00
904	.680	.681	1.440	10.58	10.30	5.32	2.00
905	.993	.972	1.440	10.58	10.30	5.32	2.00
906	.269	.350	2.130	21.28	21.00	5.32	2.00
907	.463	.463	2.130	21.28	20.40	5.32	2.00
908	.626	.660	2.130	21.28	20.40	5.32	2.00
909	.929	.942	2.130	21.28	20.80	5.32	2.00
910	1.589	1.611	2.130	21.28	20.60	5.32	2.00
911	.316	.333	2.820	31.80	28.70	5.32	2.00
912	.653	.708	2.920	31.80	30.70	5.32	2.00
913	1.024	1.042	2.920	31.80	31.00	5.32	2.00
914	1.428	1.460	2.920	31.80	30.40	5.32	2.00
915	1.959	2.056	2.920	31.80	31.90	5.32	2.00
916	.539	.500	3.550	42.56	40.60	5.32	2.00
917	.966	.976	3.550	42.56	38.20	5.32	2.00
918	1.485	1.405	3.550	42.56	39.80	5.32	2.00
919	2.155	2.090	3.550	42.56	40.00	5.32	2.00
920	2.830	2.582	3.550	42.56	42.00	5.32	2.00
921	.463	.486	4.300	52.90	50.80	5.32	2.00
922	.939	.921	4.300	52.90	50.80	5.32	2.00
923	1.401	1.389	4.300	52.90	50.10	5.32	2.00
924	1.769	1.881	4.300	52.90	51.70	5.32	2.00
926	.395	.431	6.200	78.84	67.30	5.32	2.00
927	.735	.730	6.200	78.84	78.30	5.32	2.00
928	1.170	1.111	6.200	78.84	80.10	5.32	2.00
929	1.724	1.583	6.200	78.84	76.50	5.32	2.00
930	2.343	2.077	6.200	78.84	70.10	5.32	2.00
1001	.204	.194	1.440	10.58	10.00	5.32	6.00
1002	.354	.365	1.440	10.58	10.00	5.32	6.00
1003	.490	.495	1.440	10.58	10.10	5.32	6.00
1004	.612	.625	1.440	10.58	7.10	5.32	6.00
1005	.980	1.000	1.440	10.58	10.60	5.32	6.00
1006	.316	.309	2.130	21.28	20.30	5.32	6.00
1007	.467	.491	2.130	21.28	19.30	5.32	6.00
1008	.626	.653	2.130	21.28	19.90	5.32	6.00
1009	.948	.944	2.130	21.28	20.20	5.32	6.00
1010	1.524	1.633	2.130	21.28	20.90	5.32	6.00
1011	.316	.337	2.820	31.80	28.90	5.32	6.00
1012	.687	.681	2.820	31.80	29.40	5.32	6.00
1013	1.058	1.069	2.820	31.80	30.40	5.32	6.00
1014	1.442	1.460	2.820	31.80	29.20	5.32	6.00
1015	1.932	1.905	2.820	31.80	31.00	5.32	6.00
1016	.512	.500	3.550	42.56	40.30	5.32	6.00
1017	.993	1.025	3.550	42.56	41.10	5.32	6.00
1018	1.469	1.430	3.550	42.56	39.80	5.32	6.00
1019	2.095	1.993	3.550	42.56	40.60	5.32	6.00
1020	2.640	2.667	3.550	42.56	39.80	5.32	6.00
1021	.476	.472	4.300	52.90	53.70	5.32	6.00
1022	.912	.931	4.300	52.90	51.30	5.32	6.00
1023	1.306	1.417	4.300	52.90	50.20	5.32	6.00
1024	1.759	1.917	4.300	52.90	49.80	5.32	6.00
1025	2.111	2.111	4.300	52.90	49.20	5.32	6.00
1026	.408	.393	6.200	78.84	76.50	5.32	6.00
1027	.721	.715	6.200	78.84	71.40	5.32	6.00
1028	1.127	1.056	6.200	78.84	74.90	5.32	6.00
1029	1.677	1.528	6.200	78.84	78.30	5.32	6.00
1030	2.144	1.917	6.200	78.84	80.10	5.32	6.00
1102	.418	.344	1.440	10.58	9.80	5.32	12.00
1103	.503	.575	1.440	10.58	10.10	5.32	12.00
1104	.680	.597	1.440	10.58	10.10	5.32	12.00
1105	.925	.959	1.440	10.58	10.40	5.32	12.00
1106	.340	.344	2.130	21.28	19.50	5.32	12.00
1107	.463	.385	2.130	21.28	20.90	5.32	12.00
1108	.593	.632	2.130	21.28	20.40	5.32	12.00
1109	.956	.982	2.130	21.28	20.60	5.32	12.00
1110	1.562	1.587	2.130	21.28	20.90	5.32	12.00
1111	.323	.347	2.820	31.80	28.50	5.32	12.00
1112	.701	.708	2.820	31.80	30.40	5.32	12.00
1113	1.034	1.053	2.820	31.80	30.10	5.32	12.00
1114	1.469	1.430	2.820	31.80	30.70	5.32	12.00
1115	1.966	1.973	2.820	31.80	30.70	5.32	12.00
1116	.544	.536	3.550	42.56	40.60	5.32	12.00
1117	.983	.935	3.550	42.56	39.80	5.32	12.00
1118	1.455	1.417	3.550	42.56	40.30	5.32	12.00
1119	2.095	2.028	3.550	42.56	39.50	5.32	12.00
1120	2.694	2.751	3.550	42.56	39.50	5.32	12.00
1121	.495	.509	4.300	52.90	48.80	5.32	12.00
1122	.902	.931	4.300	52.90	49.80	5.32	12.00
1123	1.388	1.444	4.300	52.90	51.30	5.32	12.00
1124	1.778	1.861	4.300	52.90	49.30	5.32	12.00

RUN	HC	HI	T	LC	L	H	E
1125	2.144	2.278	4.300	52.90	51.30	5.32	12.00
1126	.412	.431	6.200	78.84	82.00	5.32	12.00
1127	.721	.722	6.200	78.84	76.60	5.32	12.00
1128	1.197	1.100	6.200	78.84	74.90	5.32	12.00
1129	1.687	1.572	6.200	78.84	73.10	5.32	12.00
1130	2.150	1.878	6.200	78.84	74.90	5.32	12.00
1207	.700	0	2.577	31.20	0	7.80	0
1208	1.024	0	2.577	31.20	0	7.80	0
1210	1.905	0	2.577	31.20	0	7.80	0
1212	1.034	0	3.420	46.80	0	7.80	0
1213	1.508	0	3.420	46.80	0	7.80	0
1214	2.101	0	3.420	46.80	0	7.80	0
1217	.925	0	4.304	62.40	0	7.80	0
1218	1.508	0	4.304	62.40	0	7.80	0
1219	2.047	0	4.304	62.40	0	7.80	0
1227	.762	0	6.200	94.87	0	7.80	0
1228	1.017	0	6.200	94.87	0	7.80	0
1302	.517	.528	1.746	15.60	14.30	7.80	.50
1303	.762	.750	1.746	15.60	14.10	7.80	.50
1304	.889	.871	1.746	15.60	13.90	7.80	.50
1305	1.266	1.306	1.746	15.60	14.10	7.80	.50
1306	.350	.361	2.577	31.20	28.90	7.80	.50
1307	.646	.687	2.577	31.20	28.30	7.80	.50
1308	1.007	1.028	2.577	31.20	27.70	7.80	.50
1309	1.714	1.722	2.577	31.20	29.50	7.80	.50
1310	1.985	1.924	2.577	31.20	29.20	7.80	.50
1311	.490	.500	3.420	46.80	44.70	7.80	.50
1312	1.072	1.023	3.420	46.80	46.90	7.80	.50
1313	1.481	1.462	3.420	46.80	42.20	7.80	.50
1314	2.150	2.083	3.420	46.80	41.70	7.80	.50
1315	3.232	3.134	3.420	46.80	40.00	7.80	.50
1316	.490	.440	4.304	62.40	53.14	7.80	.50
1317	.916	.952	4.304	62.40	53.10	7.80	.50
1318	1.524	1.595	4.304	62.40	57.60	7.80	.50
1319	2.014	2.062	4.304	62.40	55.60	7.80	.50
1320	3.071	2.859	4.304	62.40	57.60	7.80	.50
1321	.377	.385	5.210	77.80	62.20	7.80	.50
1322	.700	.770	5.210	77.80	72.40	7.80	.50
1323	1.116	1.182	5.210	77.80	62.90	7.80	.50
1324	1.469	1.457	5.210	77.80	62.70	7.80	.50
1325	2.830	0	5.210	77.80	0	7.80	.50
1326	.327	.330	6.200	94.87	60.10	7.80	.50
1327	.680	.702	6.200	94.87	86.10	7.80	.50
1328	1.007	.952	6.200	94.87	97.90	7.80	.50
1329	1.481	1.415	6.200	94.87	83.90	7.80	.50
1330	3.071	0	6.200	94.87	0	7.80	.50
1401	.296	.389	1.746	15.60	14.10	7.80	2.00
1402	.512	.472	1.746	15.60	13.90	7.80	2.00
1403	.735	.742	1.746	15.60	14.30	7.80	2.00
1404	.980	.962	1.746	15.60	14.30	7.80	2.00
1405	1.252	1.182	1.746	15.60	14.70	7.80	2.00
1406	.323	.302	2.577	31.20	29.20	7.80	2.00
1407	.646	.687	2.577	31.20	28.60	7.80	2.00
1408	.997	1.017	2.577	31.20	28.30	7.80	2.00
1409	1.497	1.528	2.577	31.20	29.20	7.80	2.00
1410	1.939	1.924	2.577	31.20	29.10	7.80	2.00
1411	.485	.467	3.420	46.80	38.30	7.80	2.00
1412	1.007	.925	3.420	46.80	44.70	7.80	2.00
1413	1.469	1.430	3.420	46.80	44.20	7.80	2.00
1414	2.095	1.972	3.420	46.80	41.70	7.80	2.00
1415	2.776	2.773	3.420	46.80	43.70	7.80	2.00
1416	.381	.440	4.304	62.40	54.30	7.80	2.00
1417	.943	.952	4.304	62.40	58.30	7.80	2.00
1418	1.497	1.512	4.304	62.40	58.30	7.80	2.00
1419	1.986	2.034	4.304	62.40	61.30	7.80	2.00
1420	2.640	2.889	4.304	62.40	55.00	7.80	2.00
1421	.435	.440	5.210	77.80	76.20	7.80	2.00
1422	.762	.833	5.210	77.80	68.90	7.80	2.00
1423	1.212	1.197	5.210	77.80	65.80	7.80	2.00
1424	1.481	1.485	5.210	77.80	65.80	7.80	2.00
1425	2.586	2.639	5.210	77.80	71.50	7.80	2.00
1427	.680	.626	6.200	94.87	88.50	7.80	2.00
1428	1.024	.940	6.200	94.87	90.60	7.80	2.00
1429	1.528	1.375	6.200	94.87	93.50	7.80	2.00
1430	2.830	2.611	6.200	94.87	76.50	7.80	2.00
1507	.667	.681	2.577	31.20	32.60	7.80	6.00
1508	.990	.962	2.577	31.20	32.60	7.80	6.00
1510	1.912	1.944	2.577	31.20	33.67	7.80	6.00
1512	.990	.948	3.420	46.80	49.90	7.80	6.00
1513	1.401	1.375	3.420	46.80	46.62	7.80	6.00
1514	1.897	1.861	3.420	46.80	45.54	7.80	6.00
1517	.952	.986	4.304	62.40	59.28	7.80	6.00
1518	1.497	1.556	4.304	62.40	63.50	7.80	6.00
1519	2.062	1.972	4.304	62.40	64.30	7.80	6.00

RUN	HC	HI	T	LC	L	H	E
1527	.667	.618	6.200	94.87	105.50	7.80	6.00
1528	.980	.917	6.200	94.87	114.40	7.80	6.00
1529	1.388	1.361	6.200	94.87	84.50	7.80	6.00
1530	2.286	2.056	6.200	94.87	90.40	7.80	6.00
1602	.544	0	1.746	15.60	0	7.80	24.00
1603	.754	0	1.746	15.60	0	7.80	24.00
1604	1.034	0	1.746	15.60	0	7.80	24.00
1605	1.252	0	1.746	15.60	0	7.80	24.00
1606	.350	0	2.577	31.20	0	7.80	24.00
1607	.640	0	2.577	31.20	0	7.80	24.00
1608	1.007	0	2.577	31.20	0	7.80	24.00
1609	1.687	0	2.577	31.20	0	7.80	24.00
1610	2.014	0	2.577	31.20	0	7.80	24.00
1611	.512	0	3.420	46.80	0	7.80	24.00
1612	1.077	0	3.420	46.80	0	7.80	24.00
1613	1.497	0	3.420	46.80	0	7.80	24.00
1614	2.122	0	3.420	46.80	0	7.80	24.00
1615	2.801	0	3.420	46.80	0	7.80	24.00
1616	.490	0	4.304	62.40	0	7.80	24.00
1617	.943	0	4.304	62.40	0	7.80	24.00

RUN	U	U-DOT	CONVECTIVE ACCEL	HORIZONTAL DISPLACEMENT	REYNOLCS NO
107	.3089	1.3728	.0286	.1391	2.1756E 04
108	.4527	2.0116	.0614	.2038	3.1881E 04
109	.6383	2.8362	.1220	.2874	4.4949E 04
112	.4571	1.5627	.0455	.2671	3.2193E 04
113	.6776	2.3163	.0999	.3959	4.7718E 04
114	.8561	2.9266	.1595	.5002	6.0290E 04
117	.8996	2.3849	.1315	.6759	6.3351E 04
118	1.2088	3.2046	.2375	.9082	8.5125E 04
119	1.4511	3.8472	.3422	1.0903	1.0219E 05
122	.7686	1.6538	.0760	.7163	5.4125E 04
123	1.0958	2.3580	.1545	1.0212	7.7171E 04
124	1.6214	3.4890	.3383	1.5111	1.1419E 05
201	.0343	.2247	.0005	.0105	2.4176E 03
202	.0683	.4470	.0019	.0208	4.8098E 03
203	.1052	.6883	.0046	.0321	7.4056E 03
206	.2233	.9924	.0147	.1005	1.5727E 04
207	.3108	1.3811	.0284	.1399	2.1888E 04
208	.4569	2.0305	.0614	.2057	3.2179E 04
209	.6545	2.9085	.1259	.2947	4.6095E 04
210	.8007	3.5579	.1885	.3605	5.6386E 04
211	.3818	1.3050	.0314	.2230	2.6884E 04
212	.4646	1.5883	.0466	.2715	3.2720E 04
213	.7227	2.4707	.1127	.4223	5.0898E 04
214	.9795	3.3484	.2070	.5723	6.8980E 04
215	1.0977	3.7525	.2599	.6414	7.7303E 04
216	.4875	1.2924	.0384	.3662	3.4329E 04
217	.9329	2.4732	.1408	.7009	6.5697E 04
218	1.1743	3.1132	.2230	.8823	8.2697E 04
219	1.3845	3.6706	.3101	1.0402	9.7503E 04
220	1.7801	4.7194	.5126	1.3374	1.2536E 05
221	.4055	.8726	.0211	.3779	2.8560E 04
222	.8161	1.7560	.0854	.7605	5.7469E 04
223	1.0809	2.3259	.1499	1.0073	7.6120E 04
224	1.5825	3.4051	.3213	1.4747	1.1144E 05
225	2.0211	4.3490	.5241	1.8835	1.4233E 05
226	.4383	.5007	.0127	.7742	3.0868E 04
227	.8516	.9729	.0479	1.5042	5.9971E 04
228	1.4849	1.6964	.1457	2.6229	1.0457E 05
229	1.9465	2.2237	.2504	3.4382	1.3708E 05
230	2.2399	2.5589	.3315	3.9565	1.5774E 05
301	.0545	.3570	.0010	.0166	3.8410E 03
302	.1099	.7192	.0040	.0335	7.7389E 03
303	.1539	1.0075	.0078	.0470	1.0840E 04
306	.2168	.9633	.0130	.0976	1.5266E 04
307	.3007	1.3363	.0249	.1354	2.1178E 04
308	.4293	1.9076	.0508	.1933	3.0232E 04
309	.6153	2.7339	.1044	.2770	4.3328E 04
310	.8161	3.6264	.1836	.3674	5.7472E 04
311	.3339	1.1414	.0233	.1951	2.3514E 04
312	.4512	1.5423	.0426	.2636	3.1773E 04
313	.6264	2.1414	.0821	.3660	4.4113E 04
314	.9010	3.0800	.1698	.5264	6.3449E 04
315	1.0707	3.6601	.2398	.6256	7.5400E 04
316	.4648	1.2324	.0344	.3492	3.2736E 04
317	.8967	2.3773	.1279	.6737	6.3149E 04
318	1.0679	2.8311	.1814	.8023	7.5204E 04
319	1.4322	3.7971	.3263	1.0760	1.0086E 05
320	1.6505	4.3758	.4334	1.2401	1.1623E 05
321	.4758	1.0239	.0288	.4435	3.3510E 04
322	.7920	1.7041	.0797	.7381	5.5773E 04
323	1.0748	2.3128	.1467	1.0017	7.5691E 04
324	1.5839	3.4083	.3186	1.4761	1.1155E 05
325	1.8152	3.9059	.4184	1.6916	1.2783E 05
326	.4425	.5055	.0129	.7816	3.1161E 04
327	.8527	.9742	.0479	1.5062	6.0051E 04
328	1.2433	1.4203	.1019	2.1961	8.7554E 04
329	1.9491	2.2266	.2504	3.4428	1.3726E 05
330	2.0960	2.3944	.2895	3.7023	1.4760E 05
407	.3436	1.5269	.0260	.1547	2.4198E 04
408	.4851	2.1556	.0518	.2184	3.4162E 04
409	.7193	3.1964	.1140	.3238	5.0657E 04
411	.3370	1.1519	.0212	.1969	2.3730E 04
412	.4770	1.6306	.0426	.2787	3.3591E 04
413	.7425	2.5382	.1032	.4338	5.2287E 04
414	.9730	3.3269	.1771	.5685	6.8518E 04
417	.9696	2.5704	.1408	.7284	6.8278E 04
418	1.1347	3.0081	.1928	.8525	7.9905E 04
4180	1.2560	3.3300	.2363	.9437	8.8454E 04
419	1.3564	3.5960	.2755	1.0191	9.5521E 04
422	.8849	1.9042	.0958	.8247	6.2319E 04

RUN	U	U-DOT	CONVECTIVE ACCELERATION	HORIZONTAL DISPLACEMENT	REYNOLDS NUMBER
423	1.1528	2.4805	.1626	1.0743	8.1182E 04
424	1.6614	3.5749	.3376	1.5483	1.1700E 05
501	.0684	.4053	.0018	.0231	4.8199E 03
502	.1058	.6268	.0044	.0357	7.4533E 03
503	.1172	.6939	.0054	.0395	8.2513E 03
504	.1283	.7596	.0065	.0433	9.0334E 03
506	.1634	.6285	.0062	.0848	1.1504E 04
507	.2792	1.0741	.0182	.1450	1.9660E 04
508	.4192	1.6128	.0410	.2177	2.9520E 04
509	.6750	2.5972	.1062	.3505	4.7536E 04
510	.8228	3.1658	.1578	.4273	5.7944E 04
511	.3524	1.0194	.0200	.2436	2.4816E 04
512	.5186	1.5001	.0434	.3584	3.6519E 04
513	.6895	1.9945	.0767	.4766	4.8554E 04
514	.9723	2.8127	.1525	.6721	6.8473E 04
515	1.2634	3.6549	.2574	.8733	8.8974E 04
516	.4200	1.0531	.0240	.3345	2.9580E 04
517	.6114	1.5330	.0508	.4869	4.3058E 04
518	.8915	2.2351	.1080	.7099	6.2779E 04
519	1.2062	3.0242	.1978	.9605	8.4941E 04
520	1.6776	4.2061	.3826	1.3359	1.1814E 05
521	.3866	.7352	.0149	.4052	2.7226E 04
522	.6766	1.2866	.0455	.7090	4.7645E 04
523	.9182	1.7461	.0839	.9623	6.4661E 04
524	1.5038	2.8597	.2250	1.5760	1.0590E 05
525	2.1277	4.0463	.4505	2.2299	1.4984E 05
526	.4005	.3969	.0080	.8149	2.8205E 04
527	.6943	.6880	.0240	1.4127	4.8897E 04
528	1.1366	1.1262	.0642	2.3125	8.0042E 04
529	1.3887	1.3760	.0959	2.8253	9.7793E 04
530	2.5670	2.5436	.3276	5.2227	1.8078E 05
601	.0392	.1710	.0004	.0179	2.7591E 03
602	.0659	.2877	.0012	.0302	4.6441E 03
603	.0923	.4028	.0023	.0423	6.5017E 03
604	.1239	.5408	.0042	.0568	8.7281E 03
605	.1959	.8548	.0104	.0897	1.3796E 04
606	.2123	.6263	.0065	.1436	1.4951E 04
607	.3123	.9212	.0141	.2113	2.1993E 04
608	.4064	1.1989	.0239	.2750	2.8622E 04
609	.6071	1.7907	.0532	.4107	4.2751E 04
610	1.0245	3.0222	.1516	.6932	7.2150E 04
611	.2797	.6233	.0077	.2505	1.9701E 04
612	.5711	1.2725	.0319	.5114	4.0220E 04
613	.9116	2.0312	.0813	.8163	6.4200E 04
614	1.3129	2.9253	.1686	1.1756	9.2461E 04
615	1.7509	3.9011	.2999	1.5677	1.2330E 05
616	.5530	.9788	.0225	.6280	3.8946E 04
617	1.0095	1.7867	.0748	1.1462	7.1090E 04
618	1.5218	2.6935	.1700	1.7280	1.0717E 05
619	2.1796	3.8577	.3488	2.4749	1.5349E 05
620	2.8221	4.9948	.5847	3.2044	1.9874E 05
621	.4879	.7130	.0141	.6666	3.4362E 04
622	.9509	1.3895	.0535	1.2990	6.6964E 04
623	1.4486	2.1167	.1242	1.9790	1.0202E 05
624	1.8920	2.7646	.2118	2.5847	1.3324E 05
625	2.2832	3.3363	.3085	3.1191	1.6079E 05
626	.4947	.5013	.0097	.9761	3.4835E 04
627	.8848	.8967	.0311	1.7459	6.2311E 04
628	1.3133	1.3309	.0686	2.5914	9.2485E 04
629	2.0019	2.0287	.1594	3.9501	1.4098E 05
630	2.5279	2.5618	.2542	4.9880	1.7802E 05
701	.0451	.1970	.0005	.0207	3.1787E 03
702	.0717	.3129	.0014	.0328	5.0502E 03
7020	.0639	.2788	.0011	.0293	4.4998E 03
703	.0920	.4016	.0023	.0422	6.4813E 03
704	.1223	.5337	.0040	.0560	8.6142E 03
705	.2048	.8935	.0112	.0938	1.4421E 04
706	.2101	.6198	.0064	.1422	1.4796E 04
707	.2862	.8443	.0118	.1936	2.0156E 04
708	.3942	1.1628	.0224	.2667	2.7760E 04
709	.6017	1.7749	.0521	.4071	4.2373E 04
710	1.0265	3.0279	.1516	.6945	7.2286E 04
711	.2558	.5700	.0064	.2291	1.8016E 04
712	.6083	1.3553	.0361	.5446	4.2836E 04
713	.9491	2.1146	.0880	.8498	6.6837E 04
714	1.2899	2.8740	.1625	1.1549	9.0838E 04
715	1.7041	3.7968	.2836	1.5258	1.2000E 05
716	.5533	.9793	.0225	.6282	3.8964E 04
717	1.0140	1.7947	.0754	1.1514	7.1410E 04
718	1.4249	2.5220	.1489	1.6180	1.0035E 05
719	2.1867	3.8703	.3507	2.4830	1.5399E 05
720	2.8234	4.9972	.5847	3.2059	1.9883E 05
721	.5174	.7561	.0158	.7069	3.6440E 04
722	.9914	1.4486	.0581	1.3544	6.9817E 04

RUN	U	U-DOT	CONVECTIVE ACCELERATION	HORIZONTAL DISPLACEMENT	REYNOLDS NUMBER
723	1.3904	2.0316	.1143	1.8994	9.7913E 04
724	2.0415	2.9831	.2465	2.7889	1.4377E 05
725	2.5177	3.6788	.3749	3.4393	1.7730E 05
726	.4111	.4166	.0067	.8112	2.8952E 04
727	.8373	.8486	.0279	1.6522	5.8966E 04
728	1.3762	1.3946	.0753	2.7155	9.6914E 04
729	2.0544	2.0820	.1679	4.0537	1.4468E 05
730	2.4644	2.4974	.2415	4.8626	1.7355E 05
801	.0400	.1743	.0004	.0183	2.8137E 03
802	.0692	.3021	.0013	.0317	4.8752E 03
803	.0966	.4216	.0025	.0438	6.8037E 03
804	.1264	.5515	.0042	.0579	8.9007E 03
805	.2079	.9071	.0113	.0952	1.4640E 04
806	.2023	.5967	.0059	.1369	1.4245E 04
807	.2988	.8815	.0128	.2022	2.1045E 04
808	.4130	1.2184	.0244	.2795	2.9087E 04
809	.6277	1.8516	.0564	.4247	4.4204E 04
810	1.0296	3.0373	.1516	.6966	7.2510E 04
811	.2804	.6247	.0077	.2510	1.9745E 04
812	.6270	1.3971	.0383	.5614	4.4158E 04
813	.9262	2.0637	.0836	.8293	6.5227E 04
814	1.3652	3.0417	.1815	1.2223	9.6137E 04
815	1.7548	3.9099	.2999	1.5712	1.2358E 05
816	.5680	1.0053	.0236	.6449	3.9998E 04
817	.9731	1.7223	.0693	1.1049	6.8527E 04
819	2.1324	3.7742	.3330	2.4213	1.5017E 05
820	2.8256	5.0010	.5847	3.2084	1.9899E 05
821	.5177	.7565	.0158	.7072	3.6458E 04
822	1.0354	1.5129	.0633	1.4145	7.2916E 04
823	1.5683	2.2917	.1453	2.1425	1.1045E 05
824	2.0121	2.9401	.2392	2.7487	1.4170E 05
825	2.4265	3.5456	.3479	3.3148	1.7088E 05
826	.5006	.5074	.0100	.9879	3.5257E 04
827	.8213	.8323	.0268	1.6205	5.7835E 04
828	1.2963	1.3137	.0668	2.5579	9.1292E 04
829	1.9712	1.9977	.1545	3.8896	1.3882E 05
830	2.7181	2.7546	.2937	5.3634	1.9142E 05

RUN	U	U-DOT	CONVECTIVE ACCEL	HORIZONTAL DISPLACEMENT	REYNOLDS NO
902	.0702	.3061	.0013	.0321	4.9409E 03
903	.0998	.4356	.0025	.0457	7.0301E 03
904	.1363	.5948	.0047	.0624	9.5994E 03
905	.1991	.8685	.0101	.0912	1.4018E 04
906	.1761	.5195	.0044	.1192	1.2403E 04
907	.3031	.8942	.0131	.2051	2.1348E 04
908	.4099	1.2090	.0239	.2773	2.8863E 04
909	.6082	1.7942	.0526	.4115	4.2834E 04
910	1.0404	3.0689	.1539	.7039	7.3265E 04
911	.2835	.6317	.0078	.2538	1.9965E 04
912	.6066	1.3053	.0357	.5245	4.2719E 04
913	.9513	2.0469	.0879	.8226	6.6990E 04
914	1.3266	2.8545	.1709	1.1471	9.3420E 04
915	1.8198	3.9159	.3216	1.5736	1.2816E 05
916	.5491	.9719	.0220	.6235	3.8669E 04
917	.9841	1.7418	.0708	1.1174	6.9303E 04
918	1.5128	2.6776	.1673	1.7178	1.0654E 05
919	2.1954	3.8856	.3523	2.4928	1.5461E 05
920	2.8830	5.1027	.6076	3.2736	2.0303E 05
921	.5038	.7362	.0150	.6883	3.5482E 04
922	1.0218	1.4931	.0616	1.3959	7.1961E 04
923	1.5246	2.2279	.1372	2.0828	1.0737E 05
924	1.9251	2.8129	.2187	2.6298	1.3557E 05
926	.4589	.4651	.0084	.9056	3.2320E 04
927	.8540	.8654	.0290	1.6851	6.0140E 04
928	1.3594	1.3777	.0734	2.6824	9.5733E 04
929	2.0031	2.0300	.1594	3.9525	1.4106E 05
930	2.7223	2.7588	.2945	5.3716	1.9171E 05
1001	.0448	.1953	.0004	.0205	3.1524E 03
1002	.0777	.3389	.0013	.0356	5.4704E 03
1003	.1075	.4692	.0025	.0492	7.5720E 03
1004	.1343	.5860	.0038	.0615	9.4573E 03
1005	.2150	.9383	.0098	.0985	1.5144E 04
1006	.2119	.6250	.0061	.1433	1.4920E 04
1007	.3131	.9236	.0133	.2118	2.2049E 04
1008	.4197	1.2381	.0239	.2840	2.9556E 04
1009	.6356	1.8749	.0547	.4300	4.4759E 04
1010	1.0218	3.0140	.1414	.6913	7.1955E 04
1011	.2866	.6385	.0078	.2566	2.0180E 04
1012	.6230	1.3881	.0369	.5578	4.3873E 04
1013	.9594	2.1377	.0875	.8591	6.7566E 04
1014	1.3077	2.9136	.1625	1.1709	9.2089E 04
1015	1.7520	3.9036	.2917	1.5687	1.2338E 05
1016	.5247	.9288	.0199	.5958	3.6954E 04
1017	1.0177	1.8013	.0748	1.1556	7.1671E 04
1018	1.5056	2.6647	.1637	1.7096	1.0603E 05
1019	2.1472	3.8003	.3330	2.4381	1.5121E 05
1020	2.7057	4.7889	.5288	3.0723	1.9054E 05
1021	.5200	.7599	.0158	.7104	3.6621E 04
1022	.9963	1.4559	.0581	1.3611	7.0165E 04
1023	1.4268	2.0848	.1192	1.9491	1.0048E 05
1024	1.9217	2.8080	.2162	2.6252	1.3533E 05
1025	2.3062	3.3699	.3114	3.1505	1.6241E 05
1026	.4749	.4813	.0089	.9370	3.3443E 04
1027	.8392	.8505	.0279	1.6559	5.9099E 04
1028	1.3118	1.3294	.0681	2.5883	9.2378E 04
1029	1.9519	1.9781	.1509	3.8515	1.3746E 05
1030	2.4955	2.5290	.2466	4.9241	1.7574E 05
1102	.1105	.4822	.0018	.0506	7.7830E 03
1103	.1330	.5803	.0026	.0609	9.3657E 03
1104	.1798	.7845	.0047	.0823	1.2661E 04
1105	.2446	1.0671	.0088	.1120	1.7223E 04
1106	.2401	.7084	.0070	.1625	1.6911E 04
1107	.3270	.9646	.0131	.2212	2.3029E 04
1108	.4188	1.2355	.0214	.2834	2.9494E 04
1109	.6752	1.9917	.0557	.4568	4.7549E 04
1110	1.1032	3.2545	.1486	.7464	7.7690E 04
1111	.3000	.6684	.0082	.2686	2.1126E 04
1112	.6511	1.4506	.0384	.5830	4.5850E 04
1113	.9604	2.1397	.0836	.8599	6.7630E 04
1114	1.3644	3.0399	.1686	1.2216	9.6082E 04
1115	1.8260	4.0684	.3021	1.6349	1.2859E 05
1116	.5651	1.0002	.0225	.6417	3.9796E 04
1117	1.0211	1.8073	.0733	1.1595	7.1911E 04
1118	1.5114	2.6751	.1606	1.7162	1.0644E 05
1119	2.1763	3.8518	.3330	2.4711	1.5326E 05
1120	2.7985	4.9531	.5506	3.1776	1.9708E 05
1121	.5455	.7971	.0171	.7452	3.8418E 04
1122	.9941	1.4526	.0569	1.3580	7.0006E 04
1123	1.5297	2.2352	.1346	2.0897	1.0772E 05

RUN	U	U-DOT	CONVECTIVE ACCELERATION	HORIZONTAL DISPLACEMENT	REYNOLDS NUMBER
1124	1.9595	2.8632	.2209	2.6769	1.3799E 05
1125	2.3629	3.4526	.3213	3.2279	1.6640E 05
1126	.4814	.4879	.0091	.9500	3.3905E 04
1127	.8425	.8538	.0279	1.6625	5.9333E 04
1128	1.3988	1.4175	.0769	2.7600	9.8504E 04
1129	1.9714	1.9978	.1527	3.8898	1.3883E 05
1130	2.5124	2.5461	.2480	4.9574	1.7693E 05
1207	.3729	.9091	.0139	.3057	2.6258E 04
1208	.5454	1.3299	.0297	.4472	3.8412E 04
1210	1.0147	2.4741	.1026	.8320	7.1459E 04
1212	.7619	1.3998	.0388	.8295	5.3656E 04
1213	1.1112	2.0415	.0825	1.2097	7.8253E 04
1214	1.5481	2.8442	.1602	1.6854	1.0902E 05
1217	.7765	1.1335	.0303	1.0662	5.4680E 04
1218	1.2658	1.8479	.0805	1.7382	8.9143E 04
1219	1.7183	2.5084	.1483	2.3595	1.2101E 05
1227	.7059	.7154	.0165	1.4122	4.9711E 04
1228	.9421	.9548	.0294	1.8848	6.6347E 04
1302	.0823	.2961	.0013	.0458	5.7949E 03
1303	.1213	.4365	.0028	.0676	8.5410E 03
1304	.1415	.5092	.0038	.0788	9.9646E 03
1305	.2015	.7251	.0078	.1122	1.4190E 04
1306	.1866	.4550	.0035	.1530	1.3141E 04
1307	.3444	.8397	.0119	.2824	2.4254E 04
1308	.5369	1.3090	.0287	.4402	3.7807E 04
1309	.9138	2.2280	.0831	.7492	6.4351E 04
1310	1.0588	2.5815	.1115	.8681	7.4563E 04
1311	.3612	.6636	.0087	.3932	2.5437E 04
1312	.7902	1.4518	.0417	.8603	5.5650E 04
1313	1.0917	2.0057	.0796	1.1885	7.6882E 04
1314	1.5849	2.9117	.1677	1.7254	1.1161E 05
1315	2.3825	4.3770	.3790	2.5938	1.6778E 05
1316	.4114	.6006	.0085	.5649	2.8972E 04
1317	.7691	1.1227	.0297	1.0561	5.4160E 04
1318	1.2795	1.8679	.0822	1.7570	9.0109E 04
1319	1.6910	2.4685	.1435	2.3219	1.1908E 05
1320	2.5784	3.7641	.3337	3.5405	1.8158E 05
1321	.3376	.4072	.0046	.5612	2.3776E 04
1322	.6269	.7560	.0158	1.0420	4.4147E 04
1323	.9994	1.2053	.0403	1.6612	7.0383E 04
1324	1.3156	1.5866	.0698	2.1867	9.2646E 04
1325	2.5344	3.0565	.2589	4.2127	1.7848E 05
1326	.3030	.3070	.0030	.6061	2.1335E 04
1327	.6300	.6384	.0131	1.2604	4.4366E 04
1328	.9329	.9455	.0288	1.8665	6.5700E 04
1329	1.3721	1.3905	.0623	2.7450	9.6626E 04
1330	2.8452	2.8833	.2677	5.6920	2.0036E 05
1401	.0477	.1716	.0004	.0256	3.3579E 03
1402	.0825	.2968	.0013	.0459	5.8082E 03
1403	.1184	.4261	.0026	.0660	8.3380E 03
1404	.1579	.5681	.0047	.0879	1.1117E 04
1405	.2017	.7258	.0076	.1123	1.4203E 04
1406	.1727	.4211	.0030	.1416	1.2164E 04
1407	.3455	.8423	.0118	.2832	2.4328E 04
1408	.5332	1.2999	.0281	.4371	3.7546E 04
1409	.8005	1.9518	.0634	.6564	5.6376E 04
1410	1.0369	2.5281	.1063	.8502	7.3021E 04
1411	.3580	.6577	.0085	.3898	2.5212E 04
1412	.7433	1.3656	.0368	.8092	5.2346E 04
1413	1.0843	1.9921	.0783	1.1805	7.6362E 04
1414	1.5464	2.8411	.1593	1.6836	1.0890E 05
1415	2.0491	3.7646	.2796	2.[illegible]308	1.4430E 05
1416	.3201	.4673	.0051	.4396	2.2544E 04
1417	.7923	1.1567	.0315	1.0880	5.5799E 04
1418	1.2578	1.8363	.0793	1.7272	8.8580E 04
1419	1.6687	2.4361	.1396	2.2914	1.1752E 05
1420	2.2192	3.2383	.2466	3.0460	1.5621E 05
1421	.3898	.4700	.0061	.6478	2.7448E 04
1422	.6827	.8234	.0183	1.1348	4.8081E 04
1423	1.0859	1.3096	.0475	1.8050	7.6475E 04
1424	1.3270	1.6003	.0709	2.2057	9.3449E 04
1425	2.3170	2.7943	.2162	3.8513	1.6317E 05
1427	.6302	.6387	.0131	1.2608	4.4380E 04
1428	.9490	.9617	.0298	1.8986	6.6832E 04
1429	1.4161	1.4351	.0663	2.8330	9.9725E 04
1430	2.6228	2.6579	.2273	5.2471	1.8470E 05
1507	.3607	.8794	.0126	.2957	2.5400E 04
1508	.5353	1.3053	.0277	.4389	3.7701E 04
1510	1.0339	2.5209	.1034	.8477	7.2812E 04
1512	.7344	1.3493	.0356	.7996	5.1720E 04
1513	1.0393	1.9094	.0712	1.1315	7.3192E 04
1514	1.4073	2.5854	.1306	1.5321	9.9104E 04
1517	.8022	1.1710	.0321	1.1015	5.6490E 04
1518	1.2614	1.8414	.0793	1.7321	8.8830E 04
1519	1.7375	2.5364	.1505	2.3858	1.2236E 05
1527	.6189	.6272	.0126	1.2382	4.3585E 04
1528	.9093	.9215	.0273	1.8192	6.4038E 04
1529	1.2879	1.3052	.0547	2.5766	9.0699E 04
1530	2.1212	2.1496	.1483	4.2436	1.4938E 05
1602	.1312	.4721	.0014	.0731	9.2381E 03
1603	.1818	.6543	.0028	.1013	1.2804E 04
1604	.2493	.8973	.0052	.1389	1.7559E 04
1605	.3019	1.0865	.0076	.1682	2.1261E 04
1606	.2095	.5108	.0035	.1718	1.4754E 04
1607	.3831	.9340	.0116	.3141	2.6978E 04
1608	.6028	1.4696	.0287	.4942	4.2448E 04
1609	1.0038	2.4620	.0805	.8280	7.1112E 04
1610	1.2055	2.9393	.1147	.9884	8.4896E 04
1611	.3978	.7309	.0095	.4331	2.8016E 04
1612	.8368	1.5374	.0421	.9111	5.8932E 04
1613	1.1632	2.1370	.0813	1.2663	8.1914E 04
1614	1.6488	3.0292	.1634	1.7950	1.1611E 05
1615	2.1764	3.9985	.2847	2.3694	1.5327E 05
1616	.4239	.6188	.0085	.5820	2.9850E 04
1617	.8157	1.1909	.0315	1.1201	5.7447E 04

RUN	V	V-DOT	CONVECTIVE ACCEL	VERTICAL DISPLACEMENT	REYNCLCS NO
107	.0996	.4425	.0206	.0977	7.0121E 03
108	.1459	.6483	.0442	.1431	1.0275E 04
109	.2057	.9141	.0878	.2018	1.4487E 04
112	.1030	.3522	.0216	.0762	7.2555E 03
113	.1527	.5220	.0475	.1129	1.0754E 04
114	.1929	.6596	.0758	.1427	1.3588E 04
117	.1489	.3949	.0448	.0959	1.0489E 04
118	.2001	.5306	.0809	.1288	1.4094E 04
119	.2403	.6370	.1165	.1546	1.6920E 04
122	.1000	.2153	.0201	.0605	7.0447E 03
123	.1426	.3069	.0409	.0863	1.0044E 04
124	.2110	.4541	.0896	.1277	1.4862E 04
201	.0213	.1392	.0010	.0588	1.4976E 03
202	.0423	.2769	.0039	.1171	2.9795E 03
203	.0651	.4264	.0092	.1803	4.5875E 03
206	.0775	.3444	.0116	.0753	5.4578E 03
207	.1079	.4793	.0224	.1048	7.5957E 03
208	.1586	.7046	.0484	.1541	1.1167E 04
209	.2271	1.0093	.0994	.2207	1.5996E 04
210	.2779	1.2347	.1487	.2700	1.9568E 04
211	.0929	.3177	.0163	.0684	6.5445E 03
212	.1131	.3866	.0241	.0833	7.9652E 03
213	.1759	.6015	.0583	.1295	1.2390E 04
214	.2384	.8151	.1071	.1755	1.6792E 04
215	.2672	.9135	.1345	.1967	1.8818E 04
216	.0873	.2314	.0142	.0561	6.1476E 03
217	.1671	.4429	.0521	.1073	1.1765E 04
218	.2103	.5575	.0825	.1350	1.4809E 04
219	.2479	.6573	.1147	.1592	1.7461E 04
220	.3188	.8451	.1897	.2047	2.2450E 04
221	.0571	.1229	.0061	.0345	4.0230E 03
222	.1150	.2474	.0246	.0694	8.0953E 03
223	.1523	.3276	.0431	.0920	1.0723E 04
224	.2229	.4797	.0923	.1347	1.5698E 04
225	.2847	.6126	.1506	.1720	2.0050E 04
226	.0315	.0360	.0018	.0176	2.2172E 03
227	.0612	.0699	.0069	.0342	4.3077E 03
228	.1067	.1218	.0210	.0596	7.5113E 03
229	.1398	.1597	.0362	.0782	9.8462E 03
230	.1609	.1838	.0479	.0899	1.1330E 04
301	.0388	.2542	.0028	.0961	2.7348E 03
302	.0782	.5121	.0115	.1937	5.5101E 03
303	.1096	.7173	.0226	.2713	7.7182E 03
306	.0907	.4029	.0131	.0853	6.3855E 03
307	.1258	.5589	.0253	.1184	8.8584E 03
308	.1796	.7979	.0515	.1690	1.2646E 04
309	.2574	1.1436	.1058	.2422	1.8124E 04
310	.3414	1.5169	.1862	.3212	2.4040E 04
311	.0990	.3385	.0152	.0718	6.9735E 03
312	.1338	.4574	.0277	.0970	9.4228E 03
313	.1858	.6351	.0534	.1346	1.3082E 04
314	.2672	.9134	.1104	.1937	1.8817E 04
315	.3175	1.0855	.1559	.2301	2.2361E 04
316	.1019	.2701	.0158	.0649	7.1755E 03
317	.1966	.5211	.0589	.1252	1.3842E 04
318	.2341	.6206	.0835	.1491	1.6484E 04
319	.3139	.8323	.1503	.1999	2.2108E 04
320	.3618	.9591	.1996	.2304	2.5478E 04
321	.0822	.1769	.0102	.0494	5.7900E 03
322	.1368	.2944	.0284	.0822	9.6365E 03
323	.1857	.3996	.0523	.1116	1.3078E 04
324	.2737	.5889	.1135	.1645	1.9273E 04
325	.3136	.6749	.1490	.1885	2.2087E 04
326	.0391	.0446	.0023	.0218	2.7524E 03
327	.0753	.0860	.0085	.0420	5.3041E 03
328	.1098	.1255	.0181	.0613	7.7333E 03
329	.1722	.1967	.0446	.0961	1.2124E 04
330	.1851	.2115	.0515	.1033	1.3037E 04
407	.2006	.8916	.0461	.1688	1.4130E 04
408	.2833	1.2587	.0919	.2382	1.9949E 04
409	.4200	1.8665	.2020	.3533	2.9581E 04
411	.1445	.4941	.0223	.0991	1.0179E 04
412	.2046	.6995	.0448	.1403	1.4409E 04
413	.3185	1.0888	.1085	.2183	2.2429E 04
414	.4174	1.4267	.1862	.2861	2.9392E 04
417	.3125	.8284	.1013	.1931	2.2006E 04
418	.3657	.9695	.1387	.2259	2.5753E 04
4180	.4048	1.0732	.1699	.2501	2.8509E 04
419	.4372	1.1590	.1382	.2701	3.0787E 04
422	.2265	.4874	.0525	.1336	1.5952E 04

RUN	Y	Y-DOT	CONVECTIVE ACCELERATION	VERTICAL DISPLACEMENT	REYNOLDS NUMBER
423	.2951	.6350	.0891	.1741	2.0781E 04
424	.4253	.9151	.1850	.2509	2.9949E 04
501	.0364	.2153	.0027	.1604	2.5606E 03
502	.0562	.3330	.0065	.2481	3.9596E 03
503	.0622	.3686	.0080	.2747	4.3836E 03
504	.0681	.4036	.0096	.3007	4.7990E 03
506	.0433	.1666	.0035	.0501	3.0499E 03
507	.0740	.2848	.0104	.0856	5.2123E 03
508	.1111	.4276	.0234	.1286	7.8266E 03
509	.1790	.6886	.0606	.2071	1.2603E 04
510	.2182	.8394	.0900	.2524	1.5363E 04
511	.0629	.1820	.0074	.0534	4.4303E 03
512	.0926	.2678	.0160	.0785	6.5195E 03
513	.1231	.3561	.0283	.1044	8.6679E 03
514	.1736	.5021	.0562	.1473	1.2224E 04
515	.2255	.6525	.0949	.1914	1.5884E 04
516	.0628	.1575	.0073	.0489	4.4231E 03
517	.0914	.2292	.0155	.0712	6.4385E 03
518	.1333	.3342	.0331	.1038	9.3872E 03
519	.1804	.4522	.0605	.1404	1.2701E 04
520	.2508	.6289	.1170	.1953	1.7665E 04
521	.0420	.0799	.0033	.0296	2.9581E 03
522	.0735	.1399	.0100	.0517	5.1767E 03
523	.0998	.1897	.0184	.0702	7.0256E 03
524	.1634	.3107	.0495	.1150	1.1506E 04
525	.2312	.4396	.0991	.1627	1.6281E 04
526	.0216	.0214	.0009	.0140	1.5222E 03
527	.0375	.0371	.0026	.0242	2.6389E 03
528	.0613	.0608	.0070	.0397	4.3198E 03
529	.0749	.0743	.0104	.0485	5.2778E 03
530	.1385	.1373	.0355	.0896	9.7564E 03
601	.0113	.0493	.0003	.0583	7.9603E 02
602	.0190	.0830	.0007	.0981	1.3398E 03
603	.0266	.1162	.0015	.1373	1.8758E 03
604	.0358	.1560	.0026	.1844	2.5181E 03
605	.0565	.2466	.0066	.2914	3.9801E 03
606	.0311	.0918	.0020	.0479	2.1914E 03
607	.0458	.1350	.0042	.0705	3.2234E 03
608	.0596	.1757	.0071	.0918	4.1951E 03
609	.0890	.2625	.0159	.1370	6.2659E 03
610	.1502	.4430	.0454	.2313	1.0575E 04
611	.0275	.0614	.0015	.0308	1.9400E 03
612	.0562	.1253	.0063	.0629	3.9605E 03
613	.0898	.2000	.0162	.1004	6.3219E 03
614	.1293	.2881	.0335	.1447	9.1048E 03
615	.1724	.3842	.0596	.1929	1.2142E 04
616	.0407	.0721	.0033	.0401	2.8696E 03
617	.0744	.1316	.0111	.0732	5.2380E 03
618	.1121	.1985	.0252	.1103	7.8966E 03
619	.1606	.2842	.0517	.1580	1.1310E 04
620	.2079	.3680	.0866	.2045	1.4643E 04
621	.0289	.0423	.0017	.0266	2.0383E 03
622	.0564	.0824	.0064	.0519	3.9722E 03
623	.0859	.1256	.0148	.0791	6.0513E 03
624	.1122	.1640	.0252	.1033	7.9035E 03
625	.1354	.1979	.0367	.1246	9.5377E 03
626	.0197	.0200	.0008	.0170	1.3874E 03
627	.0352	.0357	.0025	.0303	2.4816E 03
628	.0523	.0530	.0055	.0450	3.6834E 03
629	.0797	.0808	.0127	.0687	5.6146E 03
630	.1007	.1020	.0203	.0867	7.0899E 03
701	.0140	.0613	.0004	.0718	9.8867E 02
702	.0223	.0973	.0009	.1141	1.5707E 03
7020	.0199	.0867	.0008	.1017	1.3995E 03
703	.0286	.1249	.0016	.1465	2.0159E 03
704	.0380	.1660	.0028	.1947	2.6793E 03
705	.0637	.2779	.0077	.3260	4.4854E 03
706	.0333	.0983	.0021	.0512	2.3464E 03
707	.0454	.1339	.0038	.0698	3.1964E 03
708	.0625	.1844	.0073	.0961	4.4023E 03
709	.0954	.2815	.0170	.1467	6.7196E 03
710	.1628	.4802	.0493	.2502	1.1463E 04
711	.0273	.0608	.0014	.0305	1.9209E 03
712	.0649	.1445	.0078	.0725	4.5671E 03
713	.1012	.2255	.0190	.1131	7.1261E 03
714	.1375	.3064	.0351	.1537	9.6850E 03
715	.1817	.4048	.0612	.2031	1.2795E 04
716	.0442	.0781	.0036	.0434	3.1092E 03
717	.0809	.1432	.0121	.0796	5.6983E 03
718	.1137	.2012	.0239	.1118	8.0073E 03
719	.1745	.3088	.0563	.1716	1.2288E 04
720	.2253	.3983	.0939	.2215	1.5866E 04
721	.0332	.0485	.0020	.0306	2.3412E 03
722	.0637	.0931	.0075	.0586	4.4856E 03

RUN	Y	Y-DOT	CONVECTIVE ACCELERATION	VERTICAL DISPLACEMENT	REYNOLDS NUMBER
723	.0893	.1305	.0148	.0822	6.2907E 03
724	.1312	.1917	.0318	.1207	9.2368E 03
725	.1618	.2364	.0484	.1488	1.1391E 04
726	.0177	.0180	.0006	.0153	1.2490E 03
727	.0361	.0366	.0024	.0311	2.5439E 03
728	.0594	.0602	.0065	.0511	4.1810E 03
729	.0886	.0898	.0145	.0763	6.2416E 03
730	.1063	.1077	.0209	.0915	7.4870E 03
801	.0138	.0600	.0003	.0695	9.6835E 02
802	.0238	.1040	.0010	.1205	1.6778E 03
803	.0335	.1463	.0019	.1729	2.3620E 03
804	.0435	.1898	.0033	.2199	3.0632E 03
805	.0715	.3122	.0088	.3617	5.0383E 03
806	.0357	.1053	.0021	.0547	2.5144E 03
807	.0528	.1556	.0047	.0808	3.7149E 03
808	.0729	.2151	.0089	.1117	5.1343E 03
809	.1108	.3268	.0205	.1698	7.8029E 03
810	.1818	.5361	.0553	.2785	1.2799E 04
811	.0333	.0742	.0018	.0372	2.3459E 03
812	.0745	.1660	.0092	.0832	5.2464E 03
813	.1100	.2452	.0201	.1228	7.7496E 03
814	.1622	.3614	.0437	.1811	1.1422E 04
815	.2085	.4645	.0723	.2327	1.4682E 04
816	.0505	.0894	.0042	.0496	3.5581E 03
817	.0866	.1532	.0124	.0850	6.0960E 03
819	.1897	.3357	.0597	.1864	1.3359E 04
820	.2514	.4449	.1049	.2469	1.7701E 04
821	.0371	.0542	.0023	.0341	2.6117E 03
822	.0742	.1084	.0091	.0682	5.2235E 03
823	.1124	.1642	.0209	.1033	7.9120E 03
824	.1441	.2106	.0344	.1325	1.0151E 04
825	.1738	.2540	.0501	.1598	1.2241E 04
826	.0241	.0244	.0010	.0207	1.6963E 03
827	.0395	.0400	.0026	.0340	2.7825E 03
828	.0624	.0632	.0064	.0537	4.3922E 03
829	.0948	.0961	.0149	.0816	6.6789E 03
830	.1308	.1325	.0283	.1126	9.2095E 03

RUN	V	V-DOT	CONVECTIVE ACCEL	VERTICAL DISPLACEMENT	REYNCLDS NO
902	.0264	.1152	.0011	.1318	1.8600E 03
903	.0376	.1640	.0022	.1875	2.6465E 03
904	.0513	.2239	.0042	.2560	3.6137E 03
905	.0749	.3270	.0089	.3738	5.2770E 03
906	.0342	.1010	.0018	.0523	2.4104E 03
907	.0589	.1738	.0053	.0900	4.1487E 03
908	.0797	.2350	.0096	.1217	5.6093E 03
909	.1182	.3487	.0212	.1805	8.3243E 03
910	.2022	.5964	.0621	.3088	1.4238E 04
911	.0371	.0827	.0021	.0414	2.6147E 03
912	.0794	.1709	.0095	.0855	5.5948E 03
913	.1246	.2681	.0234	.1341	8.7735E 03
914	.1737	.3738	.0455	.1870	1.2235E 04
915	.2383	.5128	.0857	.2566	1.6784E 04
916	.0539	.0953	.0044	.0529	3.7936E 03
917	.0965	.1709	.0140	.0948	6.7989E 03
918	.1484	.2627	.0331	.1457	1.0452E 04
919	.2154	.3812	.0698	.2114	1.5167E 04
920	.2828	.5006	.1204	.2776	1.9918E 04
921	.0398	.0582	.0024	.0366	2.8037E 03
922	.0807	.1180	.0098	.0742	5.6862E 03
923	.1205	.1760	.0218	.1107	8.4839E 03
924	.1521	.2223	.0348	.1398	1.0712E 04
926	.0244	.0247	.0009	.0210	1.7156E 03
927	.0453	.0459	.0031	.0390	3.1923E 03
928	.0722	.0731	.0078	.0621	5.0816E 03
929	.1063	.1078	.0170	.0915	7.4877E 03
930	.1445	.1464	.0314	.1244	1.0176E 04
1001	.0238	.1040	.0006	.1087	1.6792E 03
1002	.0414	.1805	.0019	.1886	2.9139E 03
1003	.0573	.2499	.0037	.2610	4.0334E 03
1004	.0715	.3121	.0057	.3260	5.0377E 03
1005	.1145	.4998	.0146	.5220	8.0669E 03
1006	.0608	.1793	.0038	.0907	4.2816E 03
1007	.0899	.2650	.0083	.1340	6.3275E 03
1008	.1204	.3553	.0149	.1796	8.4818E 03
1009	.1824	.5580	.0342	.2720	1.2845E 04
1010	.2932	.8649	.0885	.4373	2.0649E 04
1011	.0559	.1245	.0032	.0616	3.9362E 03
1012	.1215	.2703	.0150	.1340	8.5576E 03
1013	.1871	.4170	.0355	.2064	1.3179E 04
1014	.2551	.5683	.0659	.2813	1.7962E 04
1015	.3417	.7614	.1183	.3768	2.4066E 04
1016	.0769	.1361	.0060	.0750	5.4163E 03
1017	.1492	.2640	.0224	.1455	1.0505E 04
1018	.2207	.3906	.0490	.2153	1.5540E 04
1019	.3147	.5570	.0998	.3071	2.2162E 04
1020	.3966	.7019	.1584	.3869	2.7928E 04
1021	.0615	.0898	.0038	.0563	4.3293E 03
1022	.1178	.1721	.0139	.1078	8.2949E 03
1023	.1687	.2465	.0286	.1544	1.1878E 04
1024	.2272	.3320	.0519	.2079	1.5999E 04
1025	.2726	.3984	.0747	.2496	1.9200E 04
1026	.0378	.0383	.0014	.0324	2.6596E 03
1027	.0667	.0676	.0045	.0573	4.6399E 03
1028	.1043	.1057	.0109	.0896	7.3465E 03
1029	.1552	.1573	.0241	.1334	1.0932E 04
1030	.1985	.2011	.0395	.1705	1.3976E 04
1102	.0787	.3432	.0052	.2975	5.5399E 03
1103	.0947	.4130	.0075	.3580	6.6664E 03
1104	.1280	.5584	.0137	.4840	9.0123E 03
1105	.1741	.7596	.0253	.6584	1.2259E 04
1106	.0999	.2947	.0071	.1415	7.0356E 03
1107	.1360	.4013	.0131	.1926	9.5808E 03
1108	.1742	.5140	.0215	.2467	1.2271E 04
1109	.2809	.8286	.0560	.3977	1.9782E 04
1110	.4590	1.3539	.1495	.6499	3.2322E 04
1111	.0864	.1925	.0051	.0930	6.0842E 03
1112	.1875	.4178	.0241	.2019	1.3204E 04
1113	.2766	.6162	.0525	.2978	1.9477E 04
1114	.3929	.8755	.1059	.4231	2.7671E 04
1115	.5259	1.1717	.1897	.5662	3.7033E 04
1116	.1231	.2179	.0103	.1185	8.6714E 03
1117	.2225	.3938	.0335	.2142	1.5669E 04
1118	.3293	.5829	.0735	.3170	2.3193E 04
1119	.4742	.8393	.1524	.4565	3.3394E 04
1120	.6098	1.0793	.2519	.5870	4.2942E 04
1121	.0962	.1405	.0062	.0873	6.7731E 03
1122	.1753	.2561	.0207	.1590	1.2342E 04
1123	.2697	.3941	.0490	.2447	1.9992E 04

RUN	V	V-DOT	CONVECTIVE ACCELERATION	VERTICAL DISPLACEMENT	REYNOLDS NUMBER
1124	.3455	.5048	.0804	.3135	2.4328E 04
1125	.4166	.6087	.1169	.3780	2.9336E 04
1126	.0573	.0580	.0022	.0490	4.0339E 03
1127	.1002	.1016	.0067	.0858	7.0592E 03
1128	.1664	.1687	.0186	.1424	1.1720E 04
1129	.2345	.2377	.0368	.2007	1.6517E 04
1130	.2989	.3029	.0599	.2558	2.1050E 04
1207	.0374	.0912	.0028	.0702	2.6351E 03
1208	.0547	.1335	.0060	.1028	3.8547E 03
1210	.1018	.2483	.0208	.1912	7.1712E 03
1212	.0511	.0938	.0052	.0693	3.5964E 03
1213	.0745	.1368	.0111	.1011	5.2451E 03
1214	.1038	.1906	.0216	.1408	7.3076E 03
1217	.0391	.0570	.0031	.0465	2.7506E 03
1218	.0637	.0930	.0081	.0759	4.4842E 03
1219	.0864	.1262	.0150	.1030	6.0870E 03
1227	.0234	.0237	.0011	.0252	1.6456E 03
1228	.0312	.0316	.0019	.0337	2.1962E 03
1302	.0177	.0636	.0006	.1110	1.2446E 03
1303	.0260	.0937	.0013	.1637	1.8344E 03
1304	.0304	.1094	.0017	.1909	2.1401E 03
1305	.0433	.1557	.0035	.2719	3.0476E 03
1306	.0203	.0494	.0008	.0380	1.4278E 03
1307	.0374	.0912	.0026	.0702	2.6352E 03
1308	.0583	.1422	.0063	.1094	4.1078E 03
1309	.0993	.2421	.0183	.1862	6.9919E 03
1310	.1150	.2805	.0245	.2158	8.1015E 03
1311	.0262	.0482	.0013	.0356	1.8466E 03
1312	.0574	.1054	.0061	.0778	4.0398E 03
1313	.0793	.1456	.0116	.1075	5.5812E 03
1314	.1151	.2114	.0245	.1561	8.1023E 03
1315	.1730	.3177	.0553	.2346	1.2180E 04
1316	.0224	.0327	.0009	.0267	1.5786E 03
1317	.0419	.0612	.0032	.0499	2.9510E 03
1318	.0697	.1018	.0090	.0830	4.9098E 03
1319	.0921	.1345	.0157	.1097	6.4884E 03
1320	.1405	.2051	.0365	.1673	9.8937E 03
1321	.0148	.0178	.0004	.0165	1.0394E 03
1322	.0274	.0331	.0014	.0306	1.9300E 03
1323	.0437	.0527	.0035	.0488	3.0770E 03
1324	.0575	.0694	.0061	.0642	4.0502E 03
1325	.1108	.1336	.0227	.1237	7.8027E 03
1326	.0109	.0110	.0002	.0117	7.6504E 02
1327	.0226	.0229	.0009	.0244	1.5909E 03
1328	.0335	.0339	.0021	.0361	2.3559E 03
1329	.0492	.0499	.0045	.0531	3.4649E 03
1330	.1020	.1034	.0192	.1101	7.1848E 03
1401	.0125	.0450	.0002	.0776	8.8057E 02
1402	.0216	.0778	.0007	.1343	1.5231E 03
1403	.0310	.1117	.0015	.1927	2.1855E 03
1404	.0414	.1490	.0026	.2570	2.9154E 03
1405	.0529	.1903	.0043	.3283	3.7246E 03
1406	.0231	.0562	.0008	.0431	1.6233E 03
1407	.0461	.1124	.0032	.0862	3.2467E 03
1408	.0712	.1735	.0076	.1331	5.0107E 03
1409	.1068	.2605	.0172	.1998	7.5236E 03
1410	.1384	.3374	.0289	.2588	9.7450E 03
1411	.0320	.0587	.0015	.0433	2.2505E 03
1412	.0664	.1219	.0066	.0899	4.6727E 03
1413	.0968	.1778	.0141	.1311	6.8155E 03
1414	.1380	.2536	.0287	.1870	9.7213E 03
1415	.1829	.3360	.0503	.2478	1.2881E 04
1416	.0215	.0313	.0007	.0255	1.5111E 03
1417	.0531	.0775	.0042	.0632	3.7401E 03
1418	.0843	.1231	.0107	.1003	5.9373E 03
1419	.1118	.1633	.0188	.1331	7.8767E 03
1420	.1487	.2171	.0332	.1770	1.0471E 04
1421	.0210	.0253	.0007	.0234	1.4764E 03
1422	.0367	.0443	.0020	.0410	2.5862E 03
1423	.0584	.0704	.0051	.0652	4.1135E 03
1424	.0714	.0861	.0076	.0797	5.0265E 03
1425	.1246	.1503	.0233	.1391	8.7768E 03
1427	.0278	.0282	.0012	.0300	1.9583E 03
1428	.0419	.0424	.0026	.0452	2.9489E 03
1429	.0625	.0633	.0059	.0674	4.4003E 03
1430	.1157	.1173	.0201	.1249	8.1498E 03
1507	.0717	.1747	.0052	.1325	5.0472E 03
1508	.1064	.2594	.0115	.1967	7.4913E 03
1510	.2054	.5009	.0428	.3799	1.4468E 04
1512	.0980	.1801	.0097	.1321	6.9023E 03
1513	.1387	.2548	.0194	.1870	9.7678E 03
1514	.1878	.3450	.0355	.2532	1.3226E 04
1517	.0805	.1175	.0065	.0955	5.6690E 03
1518	.1266	.1848	.0161	.1502	8.9143E 03
1519	.1744	.2545	.0305	.2069	1.2279E 04
1527	.0409	.0415	.0017	.0441	2.8824E 03
1528	.0601	.0609	.0036	.0648	4.2350E 03
1529	.0852	.0863	.0073	.0918	5.9981E 03
1530	.1403	.1422	.0197	.1512	9.8788E 03
1602	.1003	.3609	.0053	.4159	7.0624E 03
1603	.1390	.5002	.0102	.5764	9.7887E 03
1604	.1906	.6860	.0191	.7905	1.3424E 04
1605	.2308	.8306	.0281	.9571	1.6254E 04
1606	.0974	.2374	.0041	.1627	6.8579E 03
1607	.1781	.4342	.0137	.2975	1.2540E 04
1608	.2802	.6831	.0340	.4681	1.9731E 04
1609	.4694	1.1444	.0955	.7842	3.3055E 04
1610	.5604	1.3663	.1360	.9362	3.9463E 04
1611	.1287	.2365	.0069	.1657	9.0654E 03
1612	.2708	.4975	.0304	.3485	1.9069E 04
1613	.3764	.6915	.0588	.4844	2.6506E 04
1614	.5335	.9802	.1181	.6866	3.7572E 04
1615	.7042	1.2938	.2058	.9063	4.9594E 04
1616	.1045	.1526	.0045	.1208	7.3595E 03
1617	.2011	.2936	.0165	.2325	1.4163E 04

CHARACTERISTIC RATIOS

RUN	HI/HC	L/LC	PI*D/LC	H/D	HC/D	HC/T**2	H/LC	HC/LC
107	.9902	.9362	.3342	2.3500	.3030	.1515	.2500	.0322
108	.9447	.9436	.3342	2.3500	.4440	.2221	.2500	.0472
109	.9797	.9548	.3342	2.3500	.6260	.3131	.2500	.0666
112	.9741	.9504	.2293	2.3500	.3380	.1001	.1715	.0247
113	.9598	.9679	.2293	2.3500	.5010	.1483	.1715	.0366
114	.9254	.9496	.2293	2.3500	.6330	.1874	.1715	.0462
117	1.1092	1.0000	.1671	2.3500	.5790	.1031	.1250	.0308
118	1.0989	1.0000	.1671	2.3500	.7780	.1385	.1250	.0414
119	1.1079	1.0053	.1671	2.3500	.9340	.1663	.1250	.0497
122	.9568	.9667	.1309	2.3500	.4650	.0545	.0979	.0194
123	.9736	.9167	.1309	2.3500	.6630	.0778	.0979	.0276
124	.9608	.9750	.1309	2.3500	.9810	.1151	.0979	.0409
201	.9135	1.3404	.6684	2.3500	.0950	.1031	.5000	.0202
202	.9793	1.4255	.6684	2.3500	.1890	.2051	.5000	.0402
203	.8386	1.4894	.6684	2.3500	.2910	.3158	.5000	.0619
206	.9731	.9149	.3342	2.3500	.2170	.1085	.2500	.0231
207	.9152	.9362	.3342	2.3500	.3020	.1510	.2500	.0321
208	.9407	.9468	.3342	2.3500	.4440	.2221	.2500	.0472
209	.9740	.9574	.3342	2.3500	.6360	.3181	.2500	.0677
210	.9284	.9574	.3342	2.3500	.7780	.3891	.2500	.0828
211	.9590	.8832	.2293	2.3500	.2810	.0832	.1715	.0205
212	.9744	.8759	.2293	2.3500	.3420	.1012	.1715	.0250
213	1.0493	.8832	.2293	2.3500	.5320	.1575	.1715	.0388
214	1.0924	.9197	.2293	2.3500	.7210	.2134	.1715	.0526
215	1.0466	.9343	.2293	2.3500	.8080	.2392	.1715	.0590
216	1.2520	.9415	.1671	2.3500	.3130	.0557	.1250	.0166
217	1.0773	.9681	.1671	2.3500	.5990	.1066	.1250	.0319
218	1.0756	1.0532	.1671	2.3500	.7540	.1342	.1250	.0401
219	1.0496	1.0372	.1671	2.3500	.8890	.1593	.1250	.0473
220	1.0803	1.0479	.1671	2.3500	1.1430	.2035	.1250	.0608
221	1.4497	.8917	.1309	2.3500	.2450	.0287	.0979	.0102
222	1.0144	.9667	.1309	2.3500	.4930	.0578	.0979	.0205
223	.9302	.9167	.1309	2.3500	.6530	.0766	.0979	.0272
224	.9835	.9417	.1309	2.3500	.9560	.1121	.0979	.0398
225	1.0235	.9542	.1309	2.3500	1.2210	.1432	.0979	.0509
226	1.1036	.9366	.0664	2.3500	.2450	.0081	.0497	.0052
227	1.0721	1.0296	.0664	2.3500	.4760	.0157	.0497	.0101
228	1.0950	.9366	.0664	2.3500	.8300	.0274	.0497	.0175
229	1.1525	.9683	.0664	2.3500	1.0880	.0360	.0497	.0230
230	1.0877	.9937	.0664	2.3500	1.2520	.0414	.0497	.0265
301	.6959	.9574	.6684	2.3500	.1350	.1465	.5000	.0287
302	.9784	.9574	.6684	2.3500	.2720	.2951	.5000	.0579
303	.8392	1.0000	.6684	2.3500	.3810	.4134	.5000	.0811
306	.9903	.9681	.3342	2.3500	.2040	.1020	.2500	.0217
307	1.0180	.9255	.3342	2.3500	.2830	.1415	.2500	.0301
308	.9688	.9468	.3342	2.3500	.4040	.2021	.2500	.0430
309	.9586	.9681	.3342	2.3500	.5790	.2896	.2500	.0616
310	.9435	.9787	.3342	2.3500	.7680	.3841	.2500	.0817
311	.9167	.9343	.2293	2.3500	.2420	.0716	.1715	.0177
312	.9316	.9562	.2293	2.3500	.3270	.0968	.1715	.0239
313	.8833	.9343	.2293	2.3500	.4540	.1344	.1715	.0331
314	.9409	.9343	.2293	2.3500	.6530	.1933	.1715	.0477
315	.9475	.9562	.2293	2.3500	.7760	.2297	.1715	.0566
316	1.1840	1.0000	.1671	2.3500	.2960	.0527	.1250	.0157
317	1.1044	1.0160	.1671	2.3500	.5710	.1017	.1250	.0304
318	1.0759	.9894	.1671	2.3500	.6800	.1211	.1250	.0362
319	1.1443	1.0479	.1671	2.3500	.9120	.1624	.1250	.0485
320	1.0813	.8777	.1671	2.3500	1.0510	.1871	.1250	.0559
321	1.1304	.9292	.1309	2.3500	.2860	.0335	.0979	.0119
322	.9695	.9292	.1309	2.3500	.4760	.0558	.0979	.0198
323	.9685	.9500	.1309	2.3500	.6460	.0758	.0979	.0269
324	1.0226	.9583	.1309	2.3500	.9520	.1117	.0979	.0397
325	.9462	.9292	.1309	2.3500	1.0910	.1280	.0979	.0455
326	1.0335	1.0169	.0664	2.3500	.2470	.0082	.0497	.0052
327	1.0601	.9619	.0664	2.3500	.4760	.0157	.0497	.0101
328	1.0981	.9789	.0664	2.3500	.6940	.0229	.0497	.0147
329	1.0584	.9556	.0664	2.3500	1.0880	.0360	.0497	.0230
330	1.1261	.9852	.0664	2.3500	1.1700	.0387	.0497	.0247
407	1.0947	.9255	.3342	2.3500	.2890	.1445	.2500	.0307
408	1.0382	.9681	.3342	2.3500	.4080	.2041	.2500	.0434
409	.9468	.9574	.3342	2.3500	.6050	.3026	.2500	.0644
411	.9240	.9708	.2293	2.3500	.2310	.0684	.1715	.0169
412	.9058	.9416	.2293	2.3500	.3270	.0968	.1715	.0239
413	1.0367	.9416	.2293	2.3500	.5090	.1507	.1715	.0372
414	.9515	.9781	.2293	2.3500	.6670	.1974	.1715	.0487
417	1.1475	1.0160	.1671	2.3500	.5990	.1066	.1250	.0319
418	1.1742	.9894	.1671	2.3500	.7010	.1248	.1250	.0373
4180	1.0430	1.0053	.1671	2.3500	.7760	.1382	.1250	.0413
419	1.0060	1.0319	.1671	2.3500	.8380	.1492	.1250	.0446
422	1.1397	.9167	.1309	2.3500	.5220	.0612	.0979	.0217
423	1.0526	.9375	.1309	2.3500	.6800	.0798	.0979	.0293

RATIOS (CONTINUED)

424	1.0187	.9667	.1309	2.3500	.9800	.1149	.0979	.0408
501	.9467	.9739	.5464	3.1400	.3020	.2683	.5461	.0525
502	1.0518	1.0017	.5464	3.1400	.4670	.4148	.5461	.0812
503	.9539	1.0087	.5464	3.1400	.5170	.4593	.5461	.0899
504	.9708	1.0261	.5464	3.1400	.5660	.5028	.5461	.0984
505	.8008	.9338	.2507	3.1400	.1890	.0709	.2506	.0151
507	.9308	.9417	.2507	3.1400	.3230	.1211	.2506	.0258
508	.8867	.9417	.2507	3.1400	.4850	.1819	.2506	.0387
509	.9071	.9417	.2507	3.1400	.7810	.2929	.2506	.0623
510	.9655	.9657	.2507	3.1400	.9520	.3570	.2506	.0760
511	1.0136	.9862	.1666	3.1400	.2990	.0634	.1665	.0159
512	1.1311	.9597	.1666	3.1400	.4400	.0933	.1665	.0233
513	1.0428	.9703	.1666	3.1400	.5850	.1240	.1665	.0310
514	1.1000	.9544	.1666	3.1400	.8250	.1749	.1665	.0437
515	1.0603	.9862	.1666	3.1400	1.0720	.2272	.1665	.0568
516	.9909	.9473	.1391	3.1400	.3270	.0521	.1390	.0145
517	.9261	.9783	.1391	3.1400	.4760	.0758	.1390	.0211
518	.8675	.9650	.1391	3.1400	.6940	.1105	.1390	.0307
519	.9390	.9960	.1391	3.1400	.9390	.1495	.1390	.0416
520	.8459	.9960	.1391	3.1400	1.3060	.2080	.1390	.0578
521	.9784	.9199	.1007	3.1400	.2720	.0249	.1006	.0087
522	.9794	.9071	.1007	3.1400	.4760	.0436	.1006	.0153
523	.9585	.8942	.1007	3.1400	.6460	.0592	.1006	.0207
524	1.0019	.9615	.1007	3.1400	1.0580	.0969	.1006	.0339
525	.9980	.9803	.1007	3.1400	1.4970	.1371	.1006	.0480
526	.9522	.9254	.0499	3.1400	.2590	.0064	.0498	.0041
527	1.0113	.9317	.0499	3.1400	.4490	.0112	.0498	.0071
528	.9986	.9984	.0499	3.1400	.7350	.0183	.0498	.0117
529	1.0430	.9984	.0499	3.1400	.8980	.0223	.0498	.0143
530	1.0950	.9984	.0499	3.1400	1.6600	.0413	.0498	.0263
601	1.0412	.9452	.2969	5.3200	.2020	.0974	.5028	.0191
602	.9844	.9735	.2969	5.3200	.3400	.1640	.5028	.0321
603	.9794	.9830	.2969	5.3200	.4760	.2296	.5028	.0450
604	1.0000	.9830	.2969	5.3200	.6390	.3082	.5028	.0604
605	1.0070	1.0113	.2969	5.3200	1.0100	.4871	.5028	.0955
606	.9703	.9586	.1476	5.3200	.3270	.0721	.2500	.0154
607	.9897	.9586	.1476	5.3200	.4810	.1060	.2500	.0226
608	.9905	.9586	.1476	5.3200	.6260	.1380	.2500	.0294
609	.9521	.9586	.1476	5.3200	.9350	.2061	.2500	.0439
610	.9529	.9492	.1476	5.3200	1.5780	.3478	.2500	.0742
611	1.0364	.9245	.0988	5.3200	.3130	.0394	.1673	.0098
612	.9481	.9371	.0988	5.3200	.6390	.0804	.1673	.0201
613	.9789	.9465	.0988	5.3200	1.0200	.1283	.1673	.0321
614	1.0367	.9843	.0988	5.3200	1.4690	.1847	.1673	.0462
615	1.0077	1.0157	.0988	5.3200	1.9590	.2463	.1673	.0616
616	1.0968	.9352	.0738	5.3200	.5440	.0432	.1250	.0128
617	1.0365	.9539	.0738	5.3200	.9930	.0788	.1250	.0233
618	1.0778	.9657	.0738	5.3200	1.4970	.1138	.1250	.0352
619	1.0720	.9657	.0738	5.3200	2.1440	.1701	.1250	.0504
620	.9609	1.0080	.0738	5.3200	2.7760	.2203	.1250	.0652
621	.9239	.9811	.0594	5.3200	.4490	.0243	.1006	.0085
622	.9134	.9924	.0594	5.3200	.8750	.0473	.1006	.0165
623	.9695	.9414	.0594	5.3200	1.3330	.0721	.1006	.0252
624	.9452	.8847	.0594	5.3200	1.7410	.0942	.1006	.0329
625	.9354	.9811	.0594	5.3200	2.1010	.1136	.1006	.0397
626	.9595	.9107	.0398	5.3200	.4260	.0111	.0675	.0054
627	1.0554	1.0236	.0398	5.3200	.7620	.0198	.0675	.0097
628	1.0550	.9500	.0398	5.3200	1.1310	.0294	.0675	.0143
629	1.0775	.9932	.0398	5.3200	1.7240	.0448	.0675	.0219
630	1.1079	.9462	.0398	5.3200	2.1770	.0566	.0675	.0276
701	1.0405	.9641	.2969	5.3200	.2310	.1114	.5028	.0218
702	1.2441	.9357	.2969	5.3200	.3670	.1770	.5028	.0347
7020	.9424	.9546	.2969	5.3200	.3270	.1577	.5028	.0309
703	.9593	.9830	.2969	5.3200	.4710	.2271	.5028	.0445
704	1.0486	.9735	.2969	5.3200	.6260	.3019	.5028	.0592
705	1.0939	1.0208	.2969	5.3200	1.0480	.5054	.5028	.0991
706	1.0125	.9445	.1476	5.3200	.3230	.0712	.2500	.0152
707	1.0209	.9821	.1476	5.3200	.4400	.0970	.2500	.0207
708	.9696	.9445	.1476	5.3200	.6060	.1336	.2500	.0285
709	.9936	.9774	.1476	5.3200	.9250	.2039	.2500	.0435
710	.9863	.9821	.1476	5.3200	1.5780	.3478	.2500	.0742
711	.9695	.9843	.0988	5.3200	.2860	.0360	.1673	.0090
712	.9898	.9748	.0988	5.3200	.6800	.0855	.1673	.0214
713	.9815	.9434	.0988	5.3200	1.0610	.1334	.1673	.0334
714	.9877	1.0252	.0988	5.3200	1.4420	.1813	.1673	.0453
715	.9799	.9371	.0988	5.3200	1.9050	.2396	.1673	.0599
716	1.0584	.9164	.0738	5.3200	.5440	.0432	.1250	.0128
717	1.0561	.9657	.0738	5.3200	.9970	.0791	.1250	.0234
718	1.0189	.9046	.0738	5.3200	1.4010	.1112	.1250	.0329
719	1.0750	.9352	.0738	5.3200	2.1500	.1706	.1250	.0505
720	1.0519	.9633	.0738	5.3200	2.7750	.2203	.1250	.0652
721	.9695	.9414	.0594	5.3200	.4760	.0257	.1006	.0090
722	.9560	.9187	.0594	5.3200	.9120	.0493	.1006	.0172
723	.9110	.9924	.0594	5.3200	1.2790	.0692	.1006	.0242

RATIOS (CONTINUED)

724	.9423	.9603	.0594	5.3200	1.8780	.1016	.1006	.0355
725	1.0167	.9811	.0594	5.3200	2.3160	.1253	.1006	.0438
726	.9100	1.0401	.0398	5.3200	.3540	.0092	.0675	.0045
727	1.0480	.9703	.0398	5.3200	.7210	.0188	.0675	.0091
728	1.0552	.9932	.0398	5.3200	1.1850	.0308	.0675	.0150
729	1.0793	.9703	.0398	5.3200	1.7690	.0460	.0675	.0224
730	1.0685	.9919	.0398	5.3200	2.1220	.0552	.0675	.0269
801	.9806	.9357	.2969	5.3200	.2020	.0974	.5028	.0191
802	.9972	.9546	.2969	5.3200	.3500	.1688	.5028	.0331
803	1.0247	.9828	.2998	5.3200	.4980	.2402	.5076	.0475
804	1.0458	.9830	.2969	5.3200	.6390	.3082	.5028	.0604
805	1.0224	.9830	.2969	5.3200	1.0510	.5068	.5028	.0993
806	.9309	.9398	.1476	5.3200	.3100	.0683	.2500	.0146
807	.9622	.9445	.1476	5.3200	.4580	.1009	.2500	.0215
808	.9922	.9633	.1476	5.3200	.6330	.1395	.2500	.0297
809	.9907	.9492	.1476	5.3200	.9620	.2120	.2500	.0452
810	.9968	.9821	.1476	5.3200	1.5780	.3478	.2500	.0742
811	.9812	.9843	.0988	5.3200	.3130	.0394	.1673	.0098
812	1.0386	.9465	.0988	5.3200	.7000	.0880	.1673	.0220
813	.9923	.9748	.0988	5.3200	1.0340	.1300	.1673	.0325
814	.9974	.9811	.0988	5.3200	1.5240	.1916	.1673	.0479
815	.9453	1.0252	.0988	5.3200	1.9590	.2463	.1673	.0616
816	1.1365	.9868	.0738	5.3200	.5580	.0443	.1250	.0131
817	1.0269	.8811	.0738	5.3200	.9560	.0759	.1250	.0225
819	1.0330	.9046	.0738	5.3200	2.0950	.1662	.1250	.0492
820	1.0409	.9657	.0738	5.3200	2.7760	.2203	.1250	.0652
821	.9794	.8973	.0594	5.3200	.4760	.0257	.1006	.0090
822	.9695	.9301	.0594	5.3200	.9520	.0515	.1006	.0180
823	.9877	.9811	.0594	5.3200	1.4420	.0780	.1006	.0273
824	.9691	.9187	.0594	5.3200	1.8500	.1001	.1006	.0350
825	1.0041	.9490	.0594	5.3200	2.2310	.1207	.1006	.0422
826	.9707	.9272	.0398	5.3200	.4310	.0112	.0675	.0055
827	.9986	.9500	.0398	5.3200	.7070	.0184	.0675	.0090
828	1.0192	1.0401	.0398	5.3200	1.1160	.0290	.0675	.0142
829	1.0795	.9488	.0398	5.3200	1.6970	.0441	.0675	.0215
830	1.0996	.9056	.0398	5.3200	2.3400	.0609	.0675	.0297

RUN	HI/HC	L/LC	PI*D/LC	H/C	HC/D	HC/T**2	H/LC	HC/LC
902	.9914	.9452	.2969	5.3200	.3500	.1688	.5028	.0331
903	.9759	.9546	.2969	5.3200	.4980	.2402	.5028	.0471
904	1.0015	.9735	.2969	5.3200	.6800	.3279	.5028	.0643
905	.9789	.9735	.2969	5.3200	.9930	.4789	.5028	.0939
906	1.3011	.9868	.1476	5.3200	.2690	.0593	.2500	.0126
907	1.0000	.9586	.1476	5.3200	.4630	.1021	.2500	.0218
908	1.0543	.9586	.1476	5.3200	.6260	.1380	.2500	.0294
909	1.0571	.9774	.1476	5.3200	.9290	.2048	.2500	.0437
910	1.0138	.9680	.1476	5.3200	1.5890	.3502	.2500	.0747
911	1.0538	.9025	.0988	5.3200	.3160	.0397	.1673	.0099
912	1.0842	.9654	.0988	5.3200	.6530	.0766	.1673	.0205
913	1.0176	.9748	.0988	5.3200	1.0240	.1201	.1673	.0322
914	1.0224	.9560	.0988	5.3200	1.4280	.1675	.1673	.0449
915	1.0495	1.0031	.0988	5.3200	1.9590	.2298	.1673	.0616
916	.9276	.9539	.0738	5.3200	.5390	.0428	.1250	.0127
917	1.0104	.8976	.0738	5.3200	.9660	.0767	.1250	.0227
918	.9461	.9352	.0738	5.3200	1.4850	.1178	.1250	.0349
919	.9281	.9398	.0738	5.3200	2.1550	.1710	.1250	.0506
920	.9124	.9868	.0738	5.3200	2.8300	.2246	.1250	.0665
921	1.0497	.9603	.0594	5.3200	.4630	.0250	.1006	.0088
922	.9808	.9603	.0594	5.3200	.9390	.0508	.1006	.0178
923	.9914	.9471	.0594	5.3200	1.4010	.0758	.1006	.0265
924	1.0633	.9584	.0594	5.3200	1.7690	.0957	.1006	.0334
926	1.0911	.8536	.0398	5.3200	.3950	.0103	.0675	.0050
927	.9932	.9932	.0398	5.3200	.7350	.0191	.0675	.0093
928	.9496	1.0160	.0398	5.3200	1.1700	.0304	.0675	.0148
929	.9182	.9703	.0398	5.3200	1.7240	.0448	.0675	.0219
930	.8865	.8891	.0398	5.3200	2.3430	.0610	.0675	.0297
1001	.9510	.9452	.2969	5.3200	.2040	.0984	.5028	.0193
1002	1.0311	.9452	.2969	5.3200	.3540	.1707	.5028	.0335
1003	1.0102	.9546	.2969	5.3200	.4900	.2363	.5028	.0463
1004	1.0212	.6715	.2969	5.3200	.6120	.2951	.5028	.0578
1005	1.0204	1.0019	.2969	5.3200	.9800	.4726	.5028	.0926
1006	.9778	.9539	.1476	5.3200	.3160	.0697	.2500	.0148
1007	1.0514	.9352	.1476	5.3200	.4670	.1029	.2500	.0219
1008	1.0431	.9352	.1476	5.3200	.6260	.1380	.2500	.0294
1009	.9958	.9492	.1476	5.3200	.9480	.2090	.2500	.0445
1010	1.0755	.9821	.1476	5.3200	1.5240	.3359	.2500	.0716
1011	1.0665	.9088	.0988	5.3200	.3160	.0397	.1673	.0099
1012	.9913	.9371	.0988	5.3200	.6870	.0864	.1673	.0216
1013	1.0104	.9560	.0988	5.3200	1.0580	.1330	.1673	.0333
1014	1.0125	.9182	.0988	5.3200	1.4420	.1813	.1673	.0453
1015	.9860	.9748	.0988	5.3200	1.9320	.2429	.1673	.0608
1016	.9766	.9469	.0738	5.3200	.5120	.0406	.1250	.0120
1017	1.0322	.9657	.0738	5.3200	.9930	.0788	.1250	.0233
1018	.9735	.9352	.0738	5.3200	1.4690	.1166	.1250	.0345
1019	.9513	.9539	.0738	5.3200	2.0950	.1662	.1250	.0492
1020	1.0102	.9352	.0738	5.3200	2.6400	.2095	.1250	.0620
1021	.9916	1.0151	.0594	5.3200	.4760	.0257	.1006	.0090
1022	1.0208	.9698	.0594	5.3200	.9120	.0493	.1006	.0172
1023	1.0850	.9490	.0594	5.3200	1.3060	.0706	.1006	.0247
1024	1.0898	.9414	.0594	5.3200	1.7590	.0951	.1006	.0333
1025	1.0000	.9301	.0594	5.3200	2.1110	.1142	.1006	.0399
1026	.9779	.9703	.0398	5.3200	.4080	.0106	.0675	.0052
1027	.9917	.9056	.0398	5.3200	.7210	.0188	.0675	.0091
1028	.9370	.9500	.0398	5.3200	1.1270	.0293	.0675	.0143
1029	.9112	.9932	.0398	5.3200	1.6770	.0436	.0675	.0213
1030	.8941	1.0160	.0398	5.3200	2.1440	.0558	.0675	.0272
1102	.8230	.9263	.2969	5.3200	.4180	.2016	.5028	.0395
1103	1.1431	.9546	.2969	5.3200	.5030	.2426	.5028	.0475
1104	.8779	.9546	.2969	5.3200	.6800	.3279	.5028	.0643
1105	1.0357	.9830	.2969	5.3200	.9250	.4461	.5028	.0874
1106	1.0118	.9164	.1476	5.3200	.3400	.0749	.2500	.0160
1107	.8315	.9821	.1476	5.3200	.4630	.1021	.2500	.0218
1108	1.0658	.9586	.1476	5.3200	.5930	.1307	.2500	.0279
1109	1.0272	.9680	.1476	5.3200	.9560	.2107	.2500	.0449
1110	1.0134	.9821	.1476	5.3200	1.5620	.3443	.2500	.0734
1111	1.0743	.8962	.0988	5.3200	.3230	.0406	.1673	.0102
1112	1.0100	.9560	.0988	5.3200	.7010	.0881	.1673	.0220
1113	1.0232	.9465	.0988	5.3200	1.0340	.1300	.1673	.0325
1114	.9735	.9654	.0988	5.3200	1.4690	.1847	.1673	.0462
1115	1.0066	.9654	.0988	5.3200	1.9660	.2472	.1673	.0618
1116	.9853	.9539	.0738	5.3200	.5440	.0432	.1250	.0128
1117	.9512	.9352	.0738	5.3200	.9830	.0780	.1250	.0231
1118	.9739	.9469	.0738	5.3200	1.4550	.1155	.1250	.0342
1119	.9680	.9281	.0738	5.3200	2.0950	.1662	.1250	.0492
1120	1.0212	.9281	.0738	5.3200	2.6940	.2138	.1250	.0633
1121	1.0283	.9225	.0594	5.3200	.4950	.0268	.1006	.0094
1122	1.0322	.9414	.0594	5.3200	.9020	.0488	.1006	.0171
1123	1.0403	.9698	.0594	5.3200	1.3880	.0751	.1006	.0262
1124	1.0467	.9319	.0594	5.3200	1.7780	.0962	.1006	.0336

RATIOS (CONTINUED)

1125	1.0625	.9698	.0594	5.3200	2.1440	.1160	.1006	.0405
1126	1.0461	1.0401	.0398	5.3200	.4120	.0107	.0675	.0052
1127	1.0014	.9716	.0398	5.3200	.7210	.0188	.0675	.0091
1128	.9190	.9500	.0398	5.3200	1.1970	.0311	.0675	.0152
1129	.9318	.9272	.0398	5.3200	1.6870	.0439	.0675	.0214
1130	.8735	.9500	.0398	5.3200	2.1500	.0559	.0675	.0273
1207	0	0	.1007	7.8000	.7000	.1054	.2500	.0224
1208	0	0	.1007	7.8000	1.0240	.1542	.2500	.0328
1210	0	0	.1007	7.8000	1.9050	.2869	.2500	.0611
1212	0	0	.0671	7.8000	1.0340	.0884	.1667	.0221
1213	0	0	.0671	7.8000	1.5080	.1289	.1667	.0322
1214	0	0	.0671	7.8000	2.1010	.1796	.1667	.0449
1217	0	0	.0503	7.8000	.9250	.0499	.1250	.0148
1218	0	0	.0503	7.8000	1.5080	.0814	.1250	.0242
1219	0	0	.0503	7.8000	2.0470	.1105	.1250	.0328
1227	0	0	.0331	7.8000	.7620	.0198	.0822	.0080
1228	0	0	.0331	7.8000	1.0170	.0265	.0822	.0107
1302	1.0213	.9167	.2014	7.8000	.5170	.1696	.5000	.0331
1303	.9843	.9038	.2014	7.8000	.7620	.2500	.5000	.0488
1304	.9798	.8910	.2014	7.8000	.8890	.2916	.5000	.0570
1305	1.0316	.9038	.2014	7.8000	1.2660	.4153	.5000	.0812
1306	1.0314	.9263	.1007	7.8000	.3500	.0527	.2500	.0112
1307	1.0635	.9071	.1007	7.8000	.6460	.0973	.2500	.0207
1308	1.0209	.8878	.1007	7.8000	1.0070	.1516	.2500	.0323
1309	1.0047	.9455	.1007	7.8000	1.7140	.2581	.2500	.0549
1310	.9688	.9359	.1007	7.8000	1.9850	.2991	.2500	.0637
1311	1.0204	.9551	.0671	7.8000	.4900	.0419	.1667	.0105
1312	.9590	1.0021	.0671	7.8000	1.0720	.0917	.1667	.0229
1313	.9467	.9017	.0671	7.8000	1.4810	.1266	.1667	.0316
1314	.9688	.8910	.0671	7.8000	2.1500	.1838	.1667	.0459
1315	.9697	.8547	.0671	7.8000	3.2320	.2763	.1667	.0691
1316	.8980	.8515	.0503	7.8000	.4900	.0265	.1250	.0079
1317	1.0393	.8510	.0503	7.8000	.9160	.0494	.1250	.0147
1318	1.0466	.9231	.0503	7.8000	1.5240	.0823	.1250	.0244
1319	1.0238	.8910	.0503	7.8000	2.0140	.1087	.1250	.0323
1320	.9310	.9231	.0503	7.8000	3.0710	.1658	.1250	.0492
1321	1.0212	.7995	.0404	7.8000	.3770	.0139	.1003	.0048
1322	1.1000	.9306	.0404	7.8000	.7000	.0258	.1003	.0090
1323	1.0591	.8085	.0404	7.8000	1.1160	.0411	.1003	.0143
1324	.9918	.8059	.0404	7.8000	1.4690	.0541	.1003	.0189
1325	0	0	.0404	7.8000	2.8300	.1043	.1003	.0364
1326	1.0092	.6335	.0331	7.8000	.3270	.0085	.0822	.0034
1327	1.0324	.9076	.0331	7.8000	.6800	.0177	.0822	.0072
1328	.9454	1.0319	.0331	7.8000	1.0070	.0262	.0822	.0106
1329	.9554	.8844	.0331	7.8000	1.4810	.0385	.0822	.0156
1330	0	0	.0331	7.8000	3.0710	.0799	.0822	.0324
1401	1.3142	.9038	.2014	7.8000	.2960	.0971	.5000	.0190
1402	.9219	.8910	.2014	7.8000	.5120	.1680	.5000	.0328
1403	1.0095	.9167	.2014	7.8000	.7350	.2411	.5000	.0471
1404	.9816	.9167	.2014	7.8000	.9800	.3215	.5000	.0628
1405	.9441	.9423	.2014	7.8000	1.2520	.4107	.5000	.0803
1406	.9350	.9359	.1007	7.8000	.3230	.0486	.2500	.0104
1407	1.0635	.9167	.1007	7.8000	.6460	.0973	.2500	.0207
1408	1.0201	.9071	.1007	7.8000	.9970	.1501	.2500	.0320
1409	1.0207	.9359	.1007	7.8000	1.4970	.2254	.2500	.0480
1410	.9923	.9006	.1007	7.8000	1.9390	.2920	.2500	.0621
1411	.9629	.8184	.0671	7.8000	.4850	.0415	.1667	.0104
1412	.9186	.9551	.0671	7.8000	1.0070	.0861	.1667	.0215
1413	.9735	.9444	.0671	7.8000	1.4690	.1256	.1667	.0314
1414	.9413	.8910	.0671	7.8000	2.0950	.1791	.1667	.0448
1415	1.0007	.9338	.0671	7.8000	2.7760	.2373	.1667	.0593
1416	1.1549	.8702	.0503	7.8000	.3810	.0206	.1250	.0061
1417	1.0095	.9343	.0503	7.8000	.9430	.0509	.1250	.0151
1418	1.0100	.9343	.0503	7.8000	1.4970	.0808	.1250	.0240
1419	1.0242	.9824	.0503	7.8000	1.9860	.1072	.1250	.0318
1420	1.0943	.8814	.0503	7.8000	2.6400	.1425	.1250	.0423
1421	1.0115	.9794	.0404	7.8000	.4350	.0160	.1003	.0056
1422	1.0932	.8856	.0404	7.8000	.7620	.0281	.1003	.0098
1423	.9876	.8458	.0404	7.8000	1.2120	.0447	.1003	.0156
1424	1.0027	.8458	.0404	7.8000	1.4810	.0546	.1003	.0190
1425	1.0205	.9190	.0404	7.8000	2.5860	.0953	.1003	.0332
1427	.9206	.9329	.0331	7.8000	.6800	.0177	.0822	.0072
1428	.9668	.9550	.0331	7.8000	1.0240	.0266	.0822	.0108
1429	.8999	.9856	.0331	7.8000	1.5280	.0398	.0822	.0161
1430	.9226	.8064	.0331	7.8000	2.8300	.0736	.0822	.0298
1507	1.0210	1.0449	.1007	7.8000	.6670	.1004	.2500	.0214
1508	.9717	1.0449	.1007	7.8000	.9900	.1491	.2500	.0317
1510	1.0167	1.0792	.1007	7.8000	1.9120	.2879	.2500	.0613
1512	.9576	1.0662	.0671	7.8000	.9900	.0846	.1667	.0212
1513	.9814	.9962	.0671	7.8000	1.4010	.1198	.1667	.0299
1514	.9810	.9731	.0671	7.8000	1.8970	.1622	.1667	.0405
1517	1.0357	.9500	.0503	7.8000	.9520	.0514	.1250	.0153
1518	1.0394	1.0176	.0503	7.8000	1.4970	.0808	.1250	.0240
1519	.9564	1.0304	.0503	7.8000	2.0620	.1113	.1250	.0330

RATIOS (CONTINUED)

1527	.9265	1.1120	.0331	7.8000	.6670	.0174	.0822	.0070
1528	.9357	1.2059	.0331	7.8000	.9800	.0255	.0822	.0103
1529	.9805	.8907	.0331	7.8000	1.3880	.0361	.0822	.0146
1530	.8994	.9529	.0331	7.8000	2.2860	.0595	.0822	.0241
1602	0	0	.2014	7.8000	.5440	.1784	.5000	.0349
1603	0	0	.2014	7.8000	.7540	.2473	.5000	.0483
1604	0	0	.2014	7.8000	1.0340	.3392	.5000	.0663
1605	0	0	.2014	7.8000	1.2520	.4107	.5000	.0803
1606	0	0	.1007	7.8000	.3500	.0527	.2500	.0112
1607	0	0	.1007	7.8000	.6400	.0964	.2500	.0205
1608	0	0	.1007	7.8000	1.0070	.1516	.2500	.0323
1609	0	0	.1007	7.8000	1.6870	.2540	.2500	.0541
1610	0	0	.1007	7.8000	2.0140	.3033	.2500	.0646
1611	0	0	.0671	7.8000	.5120	.0438	.1667	.0109
1612	0	0	.0671	7.8000	1.0770	.0921	.1667	.0230
1613	0	0	.0671	7.8000	1.4970	.1280	.1667	.0320
1614	0	0	.0671	7.8000	2.1220	.1814	.1667	.0453
1615	0	0	.0671	7.8000	2.8010	.2395	.1667	.0599
1616	0	0	.0503	7.8000	.4900	.0265	.1250	.0079
1617	0	0	.0503	7.8000	.9430	.0509	.1250	.0151

APPENDIX B -- FORCE DATA

HORIZONTAL FORCES AND PHASES

UNITS -- FORCE (LB/FT)
PHASE (DEGREES FROM WAVE CREST)

NOTE: POSITIVE PHASE VALUE IN NEGATIVE X-DIRECTION

RUN	H(FT)	T(SEC)	FORCE	PHASE	FORCE	PHASE
107	.303	1.414	-5.503	93.100	5.354	273.100
108	.444	1.414	-8.337	102.000	7.580	276.000
109	.626	1.414	-9.131	102.000	11.240	282.000
112	.338	1.838	-6.226	93.510	6.617	285.190
113	.501	1.838	-9.217	96.920	9.409	281.540
114	.633	1.838	-11.263	87.690	11.814	281.540
117	.579	2.370	-8.931	80.000	10.571	290.910
118	.779	2.370	-11.880	88.160	14.040	301.220
119	.934	2.370	-13.291	80.820	16.614	301.220
122	.465	2.920	-7.389	70.820	7.200	298.030
123	.663	2.920	-10.709	64.920	10.337	303.930
124	.981	2.920	-14.400	62.480	13.263	309.420
201	.095	.960	-1.051	81.000	.526	270.000
202	.189	.960	-1.971	108.000	1.669	279.000
203	.291	.960	-3.109	85.710	2.651	265.710
206	.217	1.414	-3.411	100.330	3.866	271.480
207	.302	1.414	-6.423	91.530	5.060	158.640
208	.444	1.414	-8.977	86.900	7.106	266.900
209	.636	1.414	-12.317	99.310	9.663	279.310
210	.778	1.414	-12.923	99.310	13.846	273.100
211	.281	1.838	-4.703	99.690	5.289	271.380
212	.342	1.838	-6.746	95.630	6.380	286.880
213	.532	1.838	-10.800	90.000	8.906	270.000
214	.721	1.838	-12.903	95.630	13.091	281.250
215	.808	1.838	-15.157	103.640	15.157	283.640
216	.313	2.370	-4.529	77.940	5.197	278.350
217	.599	2.370	-8.677	93.750	10.709	303.750
218	.754	2.370	-10.989	87.270	14.020	301.820
219	.889	2.370	-13.263	87.270	17.431	305.450
220	1.143	2.370	-15.537	94.550	20.843	305.450
221	.245	2.920	-3.637	69.680	2.894	272.900
222	.493	2.920	-7.937	60.970	6.091	296.130
223	.653	2.920	-11.180	59.020	9.663	306.890
224	.956	2.920	-14.040	54.000	13.680	315.000
225	1.221	2.920	-15.917	57.480	16.674	317.650
226	.245	5.500	-1.894	61.350	3.486	313.180
227	.476	5.500	-3.411	38.400	8.337	332.800
228	.830	5.500	-7.977	30.000	16.929	336.320
229	1.088	5.500	-9.474	26.720	21.220	337.990
230	1.252	5.500	-10.400	23.790	26.400	342.560
301	.135	.960	-1.060	102.860	.834	265.710
302	.272	.960	-2.774	52.680	2.251	263.410
303	.381	.960	-3.414	108.000	3.043	279.000
306	.204	1.414	-3.374	96.000	3.300	276.000
307	.283	1.414	-4.951	91.530	3.974	274.580
308	.404	1.414	-6.660	99.310	6.120	273.100
309	.579	1.414	-9.663	103.730	9.283	274.580
310	.768	1.414	-11.631	88.420	12.923	284.210
311	.242	1.838	-4.397	92.310	4.091	267.690
312	.327	1.838	-5.874	99.470	5.874	288.950
313	.454	1.838	-8.149	90.000	8.149	279.470
314	.653	1.838	-10.891	86.400	10.709	278.400
315	.776	1.838	-12.186	91.200	12.369	288.000
316	.296	2.370	-4.443	86.400	4.289	284.400
317	.571	2.370	-7.754	77.940	8.677	296.910
318	.680	2.370	-9.046	77.140	10.337	297.550
319	.912	2.370	-10.989	77.140	13.643	304.900
320	1.051	2.370	-12.186	80.000	15.509	301.820
321	.286	2.920	-3.714	75.480	2.651	278.710
322	.476	2.920	-6.631	65.450	5.683	300.500
323	.646	2.920	-9.540	68.430	6.300	306.450
324	.952	2.920	-11.749	59.500	10.420	315.370
325	1.091	2.920	-13.831	53.550	13.074	312.400
326	.247	5.500	-1.991	53.760	2.529	304.620
327	.476	5.500	-1.951	34.430	6.600	319.300
328	.694	5.500	-3.711	30.950	12.617	332.310
329	1.088	5.500	-7.957	30.130	16.674	333.040
330	1.170	5.500	-7.394	27.320	18.874	337.500
407	.289	1.414	-4.951	93.100	4.651	279.310
408	.408	1.414	-6.820	93.100	6.443	279.310

HORIZONTAL FORCES AND PHASES (CONTINUED)

409	.605	1.414	-9.969	93.100	8.863	279.310
411	.231	1.838	-4.009	99.470	4.306	279.470
412	.327	1.838	-5.683	94.740	5.874	279.470
413	.509	1.838	-7.769	90.000	7.769	284.210
414	.667	1.838	-9.231	85.260	10.709	284.210
417	.599	2.370	-7.200	80.820	8.337	293.880
418	.701	2.370	-8.309	80.820	8.863	293.880
4180	.776	2.370	-8.906	75.790	11.369	295.580
419	.838	2.370	-9.786	67.500	12.000	296.250
422	.522	2.920	-6.820	60.500	4.357	296.470
423	.680	2.920	-8.491	57.000	6.091	300.000
424	.980	2.920	-11.263	57.000	8.677	309.000
501	.302	1.061	-1.726	92.090	1.351	276.280
502	.467	1.061	-2.940	96.000	2.940	264.000
503	.517	1.061	-3.191	92.090	3.266	276.280
504	.566	1.061	-3.786	90.000	3.340	270.000
506	.189	1.633	-3.117	93.910	2.894	271.300
507	.323	1.633	-4.774	93.910	4.334	271.300
508	.485	1.633	-7.020	96.720	6.660	268.660
509	.781	1.633	-10.800	91.340	10.260	274.030
510	.952	1.633	-13.643	85.970	12.883	268.660
511	.299	2.172	-4.009	88.000	4.380	272.000
512	.440	2.172	-6.277	88.000	5.909	280.000
513	.585	2.172	-7.386	92.000	8.491	284.000
514	.825	2.172	-11.520	84.000	10.440	280.000
515	1.072	2.172	-14.400	84.000	14.040	288.000
516	.327	2.506	-4.751	83.080	4.529	280.380
517	.476	2.506	-7.386	87.380	6.646	283.110
518	.694	2.506	-10.440	83.080	10.440	287.310
519	.939	2.506	-12.600	85.710	12.960	294.860
520	1.306	2.506	-19.706	83.880	21.980	300.580
521	.272	3.304	-3.711	75.110	3.340	295.250
522	.476	3.304	-6.831	67.670	6.463	303.160
523	.646	3.304	-8.863	58.670	9.231	309.330
524	1.058	3.304	-14.400	53.330	14.780	320.000
525	1.497	3.304	-17.431	47.650	20.843	317.650
526	.259	6.341	-1.929	79.690	2.671	300.920
527	.449	6.341	-2.500	38.810	5.306	306.470
528	.735	6.341	-3.691	33.230	9.600	329.540
529	.898	6.341	-4.246	32.480	12.923	332.930
530	1.660	6.341	-7.200	22.150	24.120	343.380
601	.202	1.440	-0.946	97.630	.509	280.680
602	.340	1.440	-1.486	96.000	1.114	276.000
603	.476	1.440	-2.057	78.000	1.763	264.000
604	.639	1.440	-2.926	84.000	2.251	264.000
605	1.010	1.440	-4.900	86.900	4.306	273.100
606	.327	2.130	-3.086	85.910	2.646	274.090
607	.481	2.130	-4.629	94.090	3.820	270.000
608	.626	2.130	-5.583	84.940	5.583	262.920
609	.935	2.130	-9.231	90.000	7.569	265.910
610	1.578	2.130	-14.214	90.000	13.663	265.910
611	.313	2.820	-3.054	87.000	2.546	273.000
612	.639	2.820	-6.831	89.230	5.537	270.770
613	1.020	2.820	-11.180	89.230	8.906	270.770
614	1.469	2.820	-14.040	84.710	11.520	278.320
615	1.959	2.820	-17.640	83.790	16.200	285.520
616	.544	3.550	-4.677	80.820	4.157	276.730
617	.993	3.550	-10.120	76.800	7.589	278.400
618	1.497	3.550	-14.020	73.470	10.611	293.880
619	2.144	3.550	-18.360	65.680	13.680	299.190
620	2.776	3.550	-22.737	66.120	16.674	308.570
621	.449	4.300	-4.200	79.560	3.300	270.500
622	.875	4.300	-7.754	71.190	6.646	303.050
623	1.333	4.300	-11.520	60.670	9.360	307.420
624	1.741	4.300	-14.040	54.920	13.320	307.120
625	2.101	4.300	-18.000	56.310	14.760	315.750
626	.426	6.200	-2.226	79.370	2.374	291.970
627	.762	6.200	-3.600	87.270	4.860	297.270
628	1.131	6.200	-5.306	53.440	8.149	312.190
629	1.724	6.200	-7.389	45.350	13.831	325.980
630	2.177	6.200	-10.440	48.190	14.400	323.150
701	.231	1.440	-0.883	91.530	.514	274.580
702	.367	1.440	-1.574	79.320	1.051	262.370
7020	.327	1.440	-1.274	88.520	1.351	259.670
703	.471	1.440	-2.151	90.000	1.634	270.000
704	.626	1.440	-2.700	90.000	2.551	264.000
705	1.048	1.440	-4.126	90.000	4.351	270.000
706	.323	2.130	-2.851	84.000	2.626	260.000
707	.440	2.130	-3.934	94.090	3.563	278.180
708	.606	2.130	-5.271	91.030	4.900	273.100
709	.325	2.130	-8.100	95.170	7.500	277.240
710	1.578	2.130	-12.960	94.090	12.600	274.090
711	.286	2.820	-2.523	89.230	2.671	276.920
712	.680	2.820	-6.234	87.730	6.160	281.340

HORIZONTAL FORCES AND PHASES (CONTINUED)

713	1.061	2.820	-10.231	93.910	9.283	284.870
714	1.442	2.820	-13.371	99.830	12.000	293.450
715	1.905	2.820	-19.600	90.780	19.200	297.390
716	.544	3.550	-4.274	86.300	4.274	295.890
717	.997	3.550	-8.677	82.150	7.937	299.600
718	1.401	3.550	-12.960	78.370	11.880	303.670
719	2.150	3.550	-17.640	79.200	16.920	307.200
720	2.776	3.550	-20.160	73.970	22.320	320.550
721	.476	4.300	-3.637	79.120	3.637	288.790
722	.912	4.300	-7.580	84.940	7.769	307.420
723	1.279	4.300	-12.126	76.850	12.126	315.510
724	1.878	4.300	-15.120	68.760	17.280	315.510
725	2.316	4.300	-16.294	76.420	21.600	319.780
726	.354	6.200	-2.251	96.920	2.326	290.770
727	.721	6.200	-3.323	50.230	5.723	312.560
728	1.185	6.200	-4.800	45.350	10.337	320.310
729	1.769	6.200	-6.063	53.440	16.294	331.880
730	2.122	6.200	-7.920	50.630	19.800	331.880
801	.202	1.440	-0.589	97.630	.809	280.680
802	.350	1.440	-1.237	96.000	1.091	276.000
803	.498	1.440	-1.617	97.630	1.837	280.680
804	.639	1.440	-2.151	94.430	2.151	265.570
805	1.051	1.440	-3.820	97.630	3.674	274.580
806	.310	2.130	-2.449	93.180	2.300	283.760
807	.458	2.130	-3.743	94.090	3.383	278.180
808	.633	2.130	-5.143	93.030	4.774	271.010
809	.962	2.130	-7.386	94.090	6.646	274.090
810	1.578	2.130	-11.446	102.270	11.263	282.270
811	.313	2.820	-2.523	89.230	2.449	273.850
812	.700	2.820	-5.069	85.420	5.143	277.630
813	1.034	2.820	-7.569	90.760	7.569	284.370
814	1.524	2.820	-10.800	90.780	11.160	288.000
815	1.959	2.820	-12.000	93.780	14.743	287.390
816	.558	3.550	-3.563	85.260	3.340	281.840
817	.956	3.550	-6.646	73.470	6.646	296.330
819	2.095	3.550	-14.400	69.040	14.760	315.620
820	2.776	3.550	-19.200	65.230	18.800	318.930
821	.476	4.300	-3.306	74.830	2.866	297.300
822	.952	4.300	-6.251	70.790	6.820	309.440
823	1.442	4.300	-9.474	71.600	10.611	322.210
824	1.850	4.300	-12.240	64.720	13.680	327.640
825	2.231	4.300	-14.400	65.080	18.189	335.590
826	.431	6.200	-1.929	77.760	2.449	299.520
827	.707	6.200	-3.340	70.870	4.306	306.140
828	1.116	6.200	-4.063	59.060	7.937	326.250
829	1.697	6.200	12.554	-22.330	-5.723	128.370
830	2.340	6.200	-7.580	53.020	18.189	343.260

HORIZONTAL FORCES AND PHASES

UNITS -- FORCE (LB/FT)
PHASE (DEGREES FROM WAVE CREST)

NOTE: POSITIVE PHASE VALUE IN NEGATIVE X-DIRECTION

RUN	H(FT)	T(SEC)	FORCE	PHASE	FORCE	PHASE
902	.350	1.440	-1.103	112.130	1.249	289.180
903	.498	1.440	-1.837	97.630	1.469	268.470
904	.680	1.440	-2.400	100.330	2.400	271.480
905	.993	1.440	-4.040	88.520	3.674	265.570
906	.269	2.130	-1.709	93.030	2.077	266.970
907	.463	2.130	-3.860	96.000	3.340	272.000
908	.626	2.130	-5.123	97.080	4.826	275.060
909	.929	2.130	-7.560	102.270	6.480	270.000
910	1.589	2.130	-12.737	97.080	10.891	271.010
911	.316	2.820	-2.894	84.520	2.449	275.480
912	.653	2.920	-5.437	88.470	4.997	280.680
913	1.024	2.920	-8.491	90.780	7.014	284.870
914	1.428	2.920	-10.989	83.080	10.611	292.310
915	1.959	2.920	-13.680	89.230	14.760	292.310
916	.539	3.550	-3.674	85.710	3.674	281.630
917	.966	3.550	-7.200	89.380	6.831	300.410
918	1.485	3.550	-9.474	76.290	10.989	290.860
919	2.155	3.550	-14.400	73.470	12.960	311.020
920	2.830	3.550	-15.157	65.230	20.843	323.760
921	.463	4.300	-3.200	88.490	2.691	283.580
922	.939	4.300	-5.909	72.810	6.277	299.330
923	1.401	4.300	-8.640	66.740	9.360	315.510
924	1.769	4.300	-11.369	68.000	14.020	330.000
926	.395	6.200	-1.977	77.760	1.834	285.120
927	.735	6.200	-2.449	66.460	4.677	304.620
928	1.170	6.200	-3.789	58.150	7.580	321.230
929	1.724	6.200	-4.614	44.650	12.186	329.300
930	2.343	6.200	-6.120	41.860	15.120	340.470
1001	.204	1.440	-0.669	102.000	.669	276.000
1002	.354	1.440	-1.337	96.000	1.114	270.000
1003	.490	1.440	-1.709	93.100	1.486	273.100
1004	.612	1.440	-2.277	84.000	1.911	270.000
1005	.980	1.440	-3.894	90.000	3.454	270.000
1006	.316	2.130	-2.174	92.090	2.100	276.280
1007	.467	2.130	-3.231	90.000	3.086	274.090
1008	.626	2.130	-4.574	92.090	4.200	272.090
1009	.948	2.130	-7.200	86.900	6.063	273.100
1010	1.524	2.130	-10.523	95.170	10.154	281.380
1011	.316	2.820	-2.374	84.520	1.929	269.220
1012	.687	2.820	-4.826	87.650	4.454	272.350
1013	1.058	2.820	-7.386	83.790	6.463	276.210
1014	1.442	2.820	-10.611	78.260	8.717	278.610
1015	1.932	2.820	-11.880	83.090	11.520	286.150
1016	.512	3.550	-3.200	91.230	3.054	286.030
1017	.993	3.550	-6.631	79.730	6.063	285.100
1018	1.469	3.550	-8.229	77.840	7.200	296.760
1019	2.095	3.550	-11.520	62.820	10.800	297.180
1020	2.640	3.550	-12.960	59.180	13.680	310.680
1021	.476	4.300	-2.851	81.360	2.400	282.710
1022	.912	4.300	-4.800	67.500	5.169	302.730
1023	1.306	4.300	-7.200	55.830	7.200	312.690
1024	1.759	4.300	-8.280	62.700	10.800	313.480
1025	2.111	4.300	-10.080	54.300	10.800	311.730
1026	.408	6.200	-1.574	80.310	1.951	288.000
1027	.721	6.200	-2.203	70.870	3.600	300.470
1028	1.127	6.200	-2.843	66.980	6.443	312.560
1029	1.677	6.200	-3.137	53.440	9.046	317.810
1030	2.144	6.200	-4.246	52.620	12.030	326.770
1102	.418	1.440	-1.426	93.100	1.274	266.900
1103	.503	1.440	-1.911	97.630	1.689	274.580
1104	.680	1.440	-2.626	94.430	2.100	277.380
1105	.925	1.440	-3.637	90.000	3.340	264.000
1106	.340	2.130	-2.474	81.430	2.026	270.000
1107	.463	2.130	-3.043	96.000	3.191	276.000
1108	.593	2.130	-4.454	94.090	4.083	274.090
1109	.956	2.130	-6.594	93.030	6.214	275.060
1110	1.562	2.130	-10.314	97.080	9.146	275.060
1111	.323	2.820	-2.551	87.730	1.800	269.240
1112	.701	2.820	-4.397	87.000	4.320	276.000
1113	1.034	2.820	-6.974	83.790	5.774	279.310

HORIZONTAL FORCES AND PHASES (CONTINUED)

1114	1.469	2.820	-8.526	87.730	8.526	281.340
1115	1.966	2.820	-11.631	80.690	9.600	288.620
1116	.544	3.550	-3.191	81.060	2.746	274.170
1117	.983	3.550	-5.474	78.900	5.400	290.960
1118	1.455	3.550	-8.369	74.900	7.589	292.350
1119	2.095	3.550	-12.554	68.570	8.677	296.330
1120	2.694	3.550	-16.674	68.570	9.474	311.020
1121	.495	4.300	-2.774	80.690	2.026	302.070
1122	.902	4.300	-4.926	75.250	4.471	301.020
1123	1.388	4.300	-6.831	69.610	6.463	308.290
1124	1.778	4.300	-9.231	60.670	8.677	309.440
1125	2.144	4.300	-9.851	66.370	10.989	317.770
1126	.412	6.200	-1.500	74.200	1.651	283.050
1127	.721	6.200	-2.500	70.310	3.183	303.750
1128	1.197	6.200	-3.563	53.860	5.346	311.810
1129	1.687	6.200	-4.471	47.810	8.489	323.440
1130	2.150	6.200	-5.537	41.860	9.969	326.510
1207	.700	2.577	-4.500	89.140	3.974	270.860
1208	1.024	2.577	-6.226	87.480	6.811	272.520
1210	1.905	2.577	-12.883	91.700	11.557	268.300
1212	1.034	3.420	-7.589	90.630	6.031	276.920
1213	1.508	3.420	-10.231	89.380	8.906	265.660
1214	2.101	3.420	-14.020	86.810	12.694	280.850
1217	.925	4.304	-5.494	83.080	5.874	278.900
1218	1.508	4.304	-7.389	87.030	10.420	288.790
1219	2.047	4.304	-11.749	79.120	11.749	286.810
1227	.762	6.200	-3.063	87.940	3.371	294.050
1228	1.017	6.200	-3.600	87.190	5.306	315.000
1302	.517	1.746	-1.426	96.340	1.274	273.800
1303	.762	1.746	-1.874	93.700	1.874	276.160
1304	.889	1.746	-2.803	91.270	1.971	273.800
1305	1.266	1.746	-3.374	95.000	3.751	270.000
1306	.350	2.577	-2.251	86.670	1.800	273.330
1307	.646	2.577	-3.894	92.570	4.040	281.140
1308	1.007	2.577	-6.091	93.460	5.537	283.850
1309	1.714	2.577	-9.663	96.670	9.663	270.000
1310	1.986	2.577	-12.126	100.000	11.557	276.670
1311	.490	3.420	-3.334	95.660	2.577	281.960
1312	1.072	3.420	-6.277	104.680	6.091	298.720
1313	1.481	3.420	-9.663	99.310	9.851	290.480
1314	2.150	3.420	-14.969	102.500	13.451	292.500
1315	3.232	3.420	-18.189	102.130	20.843	293.620
1316	.490	4.304	-2.603	89.490	2.603	286.780
1317	.916	4.304	-5.306	94.530	6.140	295.640
1318	1.524	4.304	-8.491	101.120	11.077	305.390
1319	2.014	4.304	-11.369	105.410	17.431	290.390
1320	3.071	4.304	-15.157	89.010	20.843	304.620
1321	.377	5.210	-2.274	85.790	1.971	285.980
1322	.700	5.210	-4.289	83.330	4.671	300.000
1323	1.116	5.210	-6.251	90.000	7.200	303.330
1324	1.469	5.210	-7.569	82.570	10.709	310.460
1325	2.930	5.210	-13.643	103.330	18.569	330.000
1326	.327	6.200	-1.500	82.620	1.274	298.030
1327	.580	6.200	-2.911	85.710	3.446	311.430
1328	1.007	6.200	-4.083	92.090	6.160	309.770
1329	1.481	6.200	-5.683	106.880	9.663	315.000
1330	3.071	6.200	-9.474	75.350	21.980	323.720
1401	.296	1.746	-0.826	78.900	.826	261.370
1402	.512	1.746	-1.226	90.000	1.071	275.000
1403	.735	1.746	-1.651	90.000	1.651	265.000
1404	.980	1.746	-2.326	77.140	2.100	262.290
1405	1.252	1.746	-3.074	95.000	2.774	270.000
1406	.323	2.577	-1.609	82.570	1.454	267.520
1407	.646	2.577	-3.526	84.110	3.374	269.160
1408	.997	2.577	-5.609	90.000	5.077	270.000
1409	1.497	2.577	-8.563	94.210	7.394	272.520
1410	1.939	2.577	-10.231	94.210	9.663	272.520
1411	.485	3.420	-2.700	80.270	2.026	265.140
1412	1.007	3.420	-5.174	90.000	5.174	280.290
1413	1.469	3.420	-7.389	95.660	7.200	286.990
1414	2.095	3.420	-10.800	86.200	10.611	281.410
1415	2.776	3.420	-13.320	100.700	16.200	317.200
1416	.381	4.304	-2.197	92.000	1.894	284.000
1417	.943	4.304	-4.157	91.010	4.826	293.260
1418	1.497	4.304	-7.011	86.480	8.149	305.700
1419	1.986	4.304	-8.677	90.500	11.631	303.720
1420	2.640	4.304	-10.800	75.250	14.040	341.690
1421	.435	5.210	-1.783	88.360	1.929	281.450
1422	.762	5.210	-3.374	79.270	3.826	297.290
1423	1.212	5.210	-5.154	70.000	5.989	306.670
1424	1.481	5.210	-6.063	72.660	9.663	310.460
1425	2.586	5.210	-9.360	74.650	16.920	338.430
1427	.680	6.200	-2.400	93.540	2.474	300.470
1428	1.024	6.200	-3.220	85.040	4.357	300.470

HORIZONTAL FORCES AND PHASES (CONTINUED)

1429	1.528	6.200	-3.980	85.710	8.526	317.140
1430	2.330	6.200	-8.640	59.530	16.560	334.490
1507	.667	2.577	-3.117	89.140	2.820	274.290
1508	.990	2.577	-4.454	90.840	4.231	269.160
1510	1.912	2.577	-7.937	96.670	8.863	270.000
1512	.990	3.420	-4.306	93.150	4.529	276.920
1513	1.401	3.420	-6.300	93.240	6.120	290.070
1514	1.897	3.420	-7.957	88.730	8.149	278.870
1517	.952	4.304	-4.051	81.360	3.900	288.810
1518	1.497	4.304	-5.874	76.000	6.631	304.000
1519	2.062	4.304	-6.811	76.420	8.757	297.650
1527	.667	6.200	-1.800	98.440	2.174	303.750
1528	.980	6.200	-2.671	83.720	3.414	301.400
1529	1.388	6.200	-3.031	73.130	5.683	315.000
1530	2.286	6.200	-4.246	62.360	10.523	311.810
1602	.544	1.746	-1.149	111.550	1.149	294.080
1603	.754	1.746	-1.651	103.560	1.574	286.030
1604	1.034	1.746	-2.274	111.550	2.046	294.080
1605	1.252	1.746	-3.183	91.270	2.729	278.870
1606	.350	2.577	-1.274	90.840	1.200	275.890
1607	.640	2.577	-2.426	94.210	2.274	289.350
1608	1.007	2.577	-3.563	96.000	3.043	288.000
1609	1.587	2.577	-6.031	100.930	4.671	285.980
1610	2.014	2.577	-6.631	105.280	5.117	292.080
1611	.512	3.420	-1.651	116.690	1.951	305.380
1612	1.077	3.420	-3.714	109.790	3.260	303.830
1613	1.497	3.420	-6.251	104.280	4.357	300.410
1614	2.122	3.420	-9.926	114.210	6.811	285.520
1615	2.801	3.420	-24.631	97.020	13.263	283.400
1616	.490	4.304	-2.774	80.900	1.951	266.970
1617	.943	4.304	-2.174	96.000	2.551	276.000

VERTICAL FORCES AND PHASES

UNITS -- FORCE (LB/FT)
PHASE (DEGREES FROM WAVE CREST)

NOTE: POSITIVE PHASE VALUE IN NEGATIVE X-DIRECTION

RUN	H(FT)	T(SEC)	FORCE	PHASE	FORCE	PHASE	FORCE	PHASE	FORCE	PHASE
107	.303	1.414	-0.740	55.860	.846	229.660	0	0	0	0
108	.444	1.414	-1.011	54.000	1.543	222.000	0	0	0	0
109	.626	1.414	-1.074	66.000	2.417	234.000	0	0	0	0
112	.339	1.838	-0.546	74.810	.957	238.440	0	0	0	0
113	.501	1.838	-0.649	69.230	1.891	235.380	0	0	0	0
114	.633	1.838	-0.803	73.850	2.460	235.380	0	0	0	0
117	.579	2.370	-0.929	83.640	1.691	232.730	0	0	0	0
118	.778	2.370	-0.760	88.160	2.931	238.780	1.737	337.960	0	0
119	.934	2.370	-0.674	80.820	3.914	238.780	2.431	326.940	0	0
122	.465	2.920	-0.694	70.820	.909	200.660	0	0	0	0
123	.663	2.920	-0.589	70.820	1.926	194.750	1.443	265.570	1.871	339.340
124	.981	2.920	-0.649	59.500	2.917	166.610	1.837	258.840	3.240	339.170
201	.095	.960	-0.360	0	.360	180.000	0	0	0	0
202	.189	.960	-0.963	0	.709	189.000	0	0	0	0
203	.291	.960	-1.234	0	1.491	180.000	0	0	0	0
206	.217	1.414	-1.194	0	.674	182.950	0	0	0	0
207	.302	1.414	-1.300	0	1.286	189.150	0	0	0	0
208	.444	1.414	-2.877	0	1.463	198.620	0	0	0	0
209	.636	1.414	-4.074	0	1.914	229.660	0	0	0	0
210	.778	1.414	-3.857	0	2.263	136.550	3.394	229.660	0	0
211	.281	1.838	-1.631	0	.763	193.850	0	0	0	0
212	.342	1.838	-2.211	0	1.036	219.380	0	0	0	0
213	.532	1.838	-3.311	0	2.037	236.250	0	0	0	0
214	.721	1.838	-5.551	0	.560	101.250	-0.254	146.250	2.649	236.250
215	.808	1.838	-7.771	0	.263	103.640	-1.186	158.190	3.029	245.450
216	.313	2.370	-1.717	-22.270	-0.203	74.230	-0.657	141.030	.454	230.100
217	.593	2.370	-5.091	-26.250	.566	60.000	-2.777	138.750	1.903	251.250
218	.754	2.370	-8.371	-25.450	.946	47.270	-4.994	134.550	2.566	243.640
219	.889	2.370	-10.531	-29.090	1.486	59.910	-6.480	127.270	4.860	243.640
220	1.143	2.370	-14.040	-32.730	3.511	40.000	-9.180	116.360	6.211	236.360
221	.245	2.920	-1.154	-17.420	-0.157	72.580	-0.366	133.550	.366	232.260
222	.493	2.920	-3.229	-26.130	.211	43.550	-2.117	107.420	1.060	276.450
223	.653	2.920	-6.211	-35.410	.946	32.460	4.860	103.280	1.486	218.360
224	.956	2.920	-7.694	-39.000	2.431	27.000	-7.560	93.000	2.834	204.000
225	1.221	2.920	-7.831	-42.350	3.374	18.150	-9.180	84.710	2.834	197.560
226	.245	5.500	-1.429	-33.900	.423	30.670	-0.740	158.210	.689	261.520
227	.476	5.500	-4.643	-19.200	2.160	30.400	-1.620	145.600	-1.891	272.000
228	.830	5.500	-9.046	-18.950	4.726	17.370	-2.566	64.740	2.834	292.110
229	1.088	5.500	-10.803	-18.860	6.646	12.580	-3.046	67.600	3.186	306.550
230	1.252	5.500	-13.643	-17.440	8.811	12.690	-2.843	63.440	4.263	314.010
301	.135	.950	-0.983	0	.329	180.000	0	0	0	0
302	.272	.960	-1.734	0	1.199	184.390	0	0	0	0
303	.381	.960	-2.149	0	1.940	189.000	0	0	0	0
306	.204	1.414	-1.337	0	1.017	192.000	0	0	0	0
307	.283	1.414	-1.520	0	1.620	183.050	0	0	0	0
308	.404	1.414	-2.540	0	2.117	192.410	0	0	0	0
309	.579	1.414	-3.600	0	2.700	195.250	0	0	0	0
310	.768	1.414	-4.986	0	3.463	202.110	0	0	0	0
311	.242	1.838	-1.006	0	.954	198.460	0	0	0	0
312	.327	1.838	-1.729	0	1.080	213.160	0	0	0	0
313	.454	1.838	-2.431	0	1.297	217.890	0	0	0	0
314	.653	1.838	-3.086	0	1.259	115.200	1.046	163.200	2.203	240.000
315	.776	1.838	-3.726	0	1.080	110.400	.540	168.000	2.483	254.400
316	.296	2.370	-1.026	0	.703	205.200	0	0	0	0
317	.571	2.370	-2.377	0	.377	92.780	-0.163	167.010	1.134	263.510
318	.680	2.370	-2.729	0	.817	80.820	-0.763	172.650	1.363	264.490
319	.912	2.370	-3.251	-11.020	1.046	80.820	-1.103	168.980	2.149	264.490
320	1.051	2.370	-3.637	-14.550	1.323	76.360	-1.103	163.640	2.920	261.920
321	.286	2.920	-0.891	17.420	.277	246.770	0	0	0	0
322	.476	2.920	-1.837	0	.217	39.260	-0.109	169.590	.594	264.790
323	.646	2.920	-2.514	0	.643	71.400	-0.320	157.630	1.337	273.720
324	.952	2.920	-4.374	-8.930	.917	62.480	-1.674	148.760	1.243	276.690
325	1.091	2.920	-6.737	-14.880	1.391	56.530	-2.191	124.960	1.871	312.400
326	.247	5.500	-0.600	-6.520	0	89.590	0	0	0	0
327	.476	5.500	-2.563	-7.830	.491	50.090	-1.254	200.350	1.091	284.870
328	.694	5.500	-3.100	-6.520	1.603	45.610	-2.406	192.220	3.100	296.470
329	1.088	5.500	-10.337	-4.760	4.014	33.300	-2.491	177.620	3.737	310.940
330	1.170	5.500	-7.891	-6.430	4.291	32.140	-2.769	178.390	4.154	313.390
407	.289	1.414	-3.660	0	1.800	186.210	0	0	0	0
408	.408	1.414	-3.877	0	2.909	192.410	0	0	0	0

VERTICAL FORCES AND PHASES (CONTINUED)

409	.605	1.414	-5.400	0	4.051	204.830	0	0	0	0
411	.231	1.838	-1.909	0	1.146	203.680	0	0	0	0
412	.327	1.838	-2.354	0	1.800	208.420	0	0	0	0
413	.509	1.838	-3.046	0	2.214	222.630	0	0	0	0
414	.667	1.838	-2.834	-14.210	1.754	108.950	1.486	161.050	3.240	236.840
417	.599	2.370	-2.566	0	.374	88.160	-0.106	150.610	1.337	253.470
418	.701	2.370	-2.377	-9.180	1.080	84.490	-0.109	150.610	1.997	253.470
4180	.776	2.370	-2.406	-7.580	1.497	75.790	-0.269	155.370	2.780	265.260
419	.839	2.370	-1.443	-11.250	1.977	67.500	-1.229	157.500	2.406	270.000
422	.522	2.920	1.817	0	.260	105.880	.674	269.240	0	0
423	.680	2.920	-2.131	0	.534	75.000	-0.160	195.000	.963	279.000
424	.880	2.920	-1.891	9.000	1.457	75.000	-0.863	219.000	2.051	294.000
501	.302	1.061	-0.757	0	.486	184.190	0	0	0	0
502	.467	1.061	-1.283	0	.909	176.000	0	0	0	0
503	.517	1.061	-1.254	0	1.200	184.190	0	0	0	0
504	.566	1.061	-1.529	0	1.363	180.000	0	0	0	0
506	.189	1.633	-0.757	0	.377	187.830	0	0	0	0
507	.323	1.633	-1.200	0	.600	198.260	0	0	0	0
508	.485	1.633	-2.086	0	.954	220.300	0	0	0	0
509	.781	1.633	-3.780	-16.120	.431	107.460	.109	145.070	2.051	236.420
510	.952	1.633	-5.291	-16.120	0	91.340	-0.763	139.700	2.291	231.040
511	.299	2.172	-0.929	-12.000	.271	112.000	.546	232.000	0	0
512	.440	2.172	-2.323	-12.000	-0.377	84.000	-0.811	152.000	.540	240.000
513	.585	2.172	-2.966	-20.000	0	76.000	-1.166	144.000	1.166	244.000
514	.825	2.172	-5.831	-28.000	.163	60.000	-3.077	132.000	2.214	228.000
515	1.072	2.172	-10.894	-32.000	.811	48.000	-5.671	128.000	3.511	228.000
516	.327	2.506	-1.674	-13.850	-0.271	83.080	-0.703	152.310	.377	242.310
517	.476	2.506	-3.077	-20.970	-0.377	66.410	-1.891	139.810	.757	237.670
518	.694	2.506	-5.400	-34.620	.486	62.310	-4.751	128.080	1.511	231.920
519	.939	2.506	-9.137	-34.290	1.663	41.140	-6.369	120.000	3.463	229.710
520	1.306	2.506	-14.263	-48.930	5.123	20.970	-12.186	101.360	6.923	213.200
521	.272	3.304	-1.309	-18.130	-0.217	64.750	-0.817	142.450	.163	251.220
522	.476	3.304	-2.971	-48.720	.323	40.600	-2.591	116.390	.971	235.490
523	.646	3.304	-4.914	-37.330	1.351	32.000	-4.429	106.670	1.787	232.000
524	1.059	3.304	-8.723	-40.000	4.846	21.330	-8.586	90.670	2.631	279.330
525	1.497	3.304	-11.369	-42.350	8.811	10.590	-12.789	79.410	3.126	211.760
526	.259	6.341	-1.711	-35.730	0	39.850	-1.017	122.290	.490	240.460
527	.449	6.341	-3.240	-36.130	1.189	21.410	-1.511	112.420	1.297	228.850
528	.735	6.341	-5.723	-33.230	3.730	13.850	-2.160	94.150	2.323	249.230
529	.898	6.341	-6.211	-24.360	5.266	13.530	-2.026	113.680	2.971	254.440
530	1.660	6.341	-11.937	-22.150	12.220	5.540	-2.843	135.690	3.411	246.460
601	.202	1.440	-0.080	73.220	.080	219.660	0	0	0	0
602	.340	1.440	-0.191	48.000	.109	222.000	0	0	0	0
603	.476	1.440	-0.297	42.000	.134	216.000	0	0	0	0
604	.639	1.440	-0.291	36.000	.320	210.000	0	0	0	0
605	1.010	1.440	-0.580	43.450	.551	204.830	0	0	0	0
606	.327	2.130	-0.271	65.450	.246	216.820	0	0	0	0
607	.481	2.130	-0.380	73.640	.434	212.730	0	0	0	0
608	.626	2.130	-0.274	64.720	.883	202.250	0	0	0	0
609	.935	2.130	-0.634	73.640	1.269	200.450	0	0	0	0
610	1.578	2.130	.937	-20.450	-1.157	73.640	2.920	196.360	.660	268.160
611	.313	2.820	-0.326	75.000	.189	231.000	0	0	0	0
612	.639	2.820	.440	-12.310	-0.520	76.920	.849	200.000	.329	292.310
613	1.020	2.820	1.337	-15.380	-0.517	80.000	2.129	193.850	.817	283.080
614	1.469	2.820	2.671	-6.050	-0.891	75.630	3.617	187.560	1.226	281.340
615	1.959	2.820	5.683	-12.410	-1.137	74.480	6.251	183.100	1.989	273.100
616	.544	3.550	.320	-14.690	-0.346	75.920	.586	193.470	.240	288.980
617	.993	3.550	1.763	-7.200	-0.460	72.000	2.063	180.000	.677	268.800
618	1.497	3.550	4.223	-9.830	-0.309	66.120	3.689	173.880	.963	263.390
619	2.144	3.550	9.180	-26.760	-1.486	51.080	7.291	138.650	1.486	257.840
620	2.776	3.550	16.726	-22.040	-0.923	46.530	10.931	120.000	2.371	252.250
621	.449	4.300	.460	-19.890	-0.109	69.610	.757	190.940	.377	278.450
622	.875	4.300	1.574	-8.140	-0.537	69.150	1.546	181.020	.243	276.610
623	1.333	4.300	5.266	-18.200	-0.674	56.630	3.780	145.620	.811	260.900
624	1.741	4.300	9.586	-28.460	-0.811	44.750	7.694	126.100	1.620	258.310
625	2.101	4.300	15.509	-22.120	-1.109	46.260	10.386	118.660	1.800	269.500
626	.426	6.200	.409	-14.170	-0.137	76.540	.683	206.930	.329	297.540
627	.762	6.200	1.426	-8.180	-0.440	76.360	1.097	204.550	.274	283.540
628	1.131	6.200	4.806	-16.880	-0.323	59.060	2.431	202.500	1.026	284.060
629	1.724	6.200	8.863	-14.170	-0.969	51.020	3.323	204.090	1.386	297.640
630	2.177	6.200	17.586	-17.010	.554	42.520	4.846	208.110	2.354	310.470
701	.231	1.440	-0.163	0	.189	176.590	0	0	0	0
702	.367	1.440	-0.251	0	.203	176.950	0	0	0	0
7020	.327	1.440	-0.414	0	.137	182.950	0	0	0	0
703	.471	1.440	-0.614	0	.186	186.000	0	0	0	0
704	.626	1.440	-0.863	0	.297	186.000	0	0	0	0
705	1.048	1.440	-1.129	0	.886	192.000	0	0	0	0
706	.323	2.130	-0.500	0	.109	204.000	0	0	0	0
707	.440	2.130	-0.926	0	.246	237.270	0	0	0	0
708	.606	2.130	-1.423	-12.410	-0.109	111.720	-0.160	153.100	.429	231.720
709	.325	2.130	-3.014	-20.690	-0.329	78.620	-1.043	148.970	.906	235.860
710	1.578	2.130	-6.923	-32.730	0	49.090	-4.846	130.910	3.046	225.000
711	.286	2.820	-0.600	-9.230	-0.054	107.690	-0.217	166.150	.109	240.000
712	.580	2.820	-2.591	-30.250	0	57.480	-1.309	136.130	.929	235.970

VERTICAL FORCES AND PHASES (CONTINUED)

713	1.061	2.820	-5.294	-46.960	.803	37.570	-4.437	122.090	2.566	225.390
714	1.442	2.820	-8.911	-48.400	2.566	30.250	-8.100	117.980	4.994	214.790
715	1.905	2.820	-11.340	-65.740	4.860	12.520	-12.151	97.040	7.560	203.480
716	.544	3.550	-1.977	-34.520	.106	51.780	-1.443	133.150	.480	239.180
717	.797	3.550	-5.129	-45.910	1.637	28.990	-4.800	108.720	2.400	212.620
718	1.401	3.550	-8.526	-63.670	4.831	9.860	-9.094	95.510	4.549	199.370
719	2.150	3.550	-9.451	-57.600	7.550	0	-12.420	84.000	5.751	177.600
720	2.776	3.550	-9.380	-51.790	12.220	4.930	-11.937	78.900	7.106	170.140
721	.476	4.300	-2.106	-35.600	.054	47.470	-1.457	122.640	.540	221.540
722	.312	4.300	-4.854	-48.540	2.563	20.220	-4.471	101.120	2.563	205.290
723	1.279	4.300	-7.560	-52.580	5.131	12.130	-8.371	91.010	3.780	198.200
724	1.878	4.300	-8.100	-56.630	8.100	-6.070	-11.071	76.850	6.211	167.870
725	2.316	4.300	-9.094	-52.290	14.211	-12.070	-8.811	76.420	6.537	154.920
726	.554	6.200	-1.620	-49.850	.054	33.230	-1.080	113.540	.540	221.540
727	.721	6.200	-3.780	-44.650	2.051	19.530	-2.809	100.470	2.269	214.880
728	1.185	6.200	-4.360	-45.350	5.266	0	-3.914	90.710	3.646	203.760
729	1.769	6.200	-6.614	-39.380	9.991	-8.440	-5.266	81.560	5.265	213.750
730	2.122	6.200	-9.720	-39.380	14.040	-8.440	-7.560	78.750	4.860	196.980
801	.202	1.440	-0.194	24.410	.166	195.250	0	0	0	0
802	.350	1.440	-0.326	18.000	.297	186.000	0	0	0	0
803	.498	1.440	-0.569	18.310	.380	195.250	0	0	0	0
804	.639	1.440	-0.654	11.800	.517	188.850	0	0	0	0
805	1.051	1.440	-1.037	12.200	.900	195.250	0	0	0	0
806	.310	2.130	-0.440	16.940	.220	203.290	0	0	0	0
807	.458	2.130	-0.603	8.130	.411	212.730	0	0	0	0
808	.633	2.130	-0.840	12.130	.569	218.430	0	0	0	0
809	.962	2.130	-1.274	0	.869	237.270	0	0	0	0
810	1.579	2.130	-3.583	0	-0.386	98.180	-0.551	130.910	1.709	237.270
811	.313	2.820	-0.351	15.380	.139	236.920	0	0	0	0
812	.700	2.820	-1.046	0	-0.054	94.580	-0.137	137.290	.386	250.170
813	1.034	2.820	-2.400	-18.150	.333	63.530	-1.829	145.210	1.254	242.020
814	1.524	2.820	-6.763	-25.040	1.471	53.220	-5.017	144.000	3.000	234.780
815	1.959	2.820	-12.186	-27.230	4.014	36.300	-8.586	130.080	6.786	220.840
816	.558	3.550	-0.703	0	-0.029	82.890	-0.217	149.210	.271	246.320
817	.956	3.550	-4.017	-31.840	.814	48.980	-2.414	134.690	1.600	235.100
819	2.095	3.550	-11.880	-41.920	3.180	9.860	-11.880	103.560	6.211	193.330
820	2.776	3.550	-14.494	-36.230	11.937	2.420	-11.937	99.060	7.389	171.540
821	.476	4.300	-0.674	-8.090	-0.086	80.900	-0.111	125.390	.986	246.740
822	.952	4.300	-4.566	-22.250	1.560	36.400	-3.063	127.420	1.671	236.630
823	1.442	4.300	-8.100	-29.830	5.671	21.880	-7.291	111.380	3.240	208.840
824	1.850	4.300	-11.369	-30.340	11.369	9.090	-11.369	99.100	4.263	180.000
825	2.231	4.300	-11.369	-36.610	12.506	6.100	-13.357	89.490	5.683	176.950
826	.431	6.200	-1.351	-23.040	-0.111	51.840	-0.843	129.600	.394	241.920
827	.707	6.200	-2.646	-34.020	1.763	19.840	-1.763	121.890	2.040	229.610
828	1.116	6.200	-5.131	-30.940	3.914	11.250	-4.051	115.310	2.160	222.190
829	1.697	6.200	-7.614	-22.330	10.663	5.580	-5.954	110.230	2.491	230.230
830	2.340	6.200	-8.640	-25.120	13.771	0	-5.131	92.090	4.051	203.300

VERTICAL FORCES AND PHASES (CONTINUED)

RUN	H(FT)	T(SEC)	FORCE	PHASE	FORCE	PHASE	FORCE	PHASE	FORCE	PHASE
902	.350	1.440	-0.420	23.610	.289	194.750	0	0	0	0
903	.498	1.440	-0.603	12.200	.394	183.050	0	0	0	0
904	.680	1.440	-0.843	11.800	.554	188.850	0	0	0	0
905	.993	1.440	-1.203	0	.963	182.950	0	0	0	0
906	.269	2.130	-0.451	12.130	.266	202.250	0	0	0	0
907	.463	2.130	-0.663	12.000	.477	188.000	0	0	0	0
908	.626	2.130	-0.840	12.130	.654	206.290	0	0	0	0
909	.929	2.130	-1.474	8.180	.843	216.820	0	0	0	0
910	1.389	2.130	-3.229	0	1.614	222.470	0	0	0	0
911	.316	2.820	-0.291	9.390	.317	209.740	0	0	0	0
912	.553	2.920	-0.997	0	.340	237.970	0	0	0	0
913	1.024	2.920	-1.809	-12.520	-0.134	81.390	-0.637	144.000	.771	250.430
914	1.428	2.920	-5.271	-24.620	.514	46.150	-3.343	147.690	1.800	243.080
915	1.959	2.920	-10.800	-24.620	2.834	46.150	-7.154	135.380	6.346	230.770
916	.539	3.550	-0.903	0	-0.026	102.860	.214	240.000	0	0
917	.366	3.550	-3.886	-29.790	.374	62.070	-2.006	148.970	1.097	243.310
918	1.485	3.550	-6.780	-23.840	2.511	42.910	-4.646	126.360	4.020	214.570
919	2.155	3.550	-12.600	-31.840	7.457	19.590	-10.900	112.650	7.457	193.470
920	2.830	3.550	-14.143	-26.580	13.114	16.910	-12.086	108.720	8.229	183.620
921	.463	4.300	-0.497	-6.030	.106	90.500	.340	247.370	0	0
922	.339	4.300	-4.114	-20.220	.771	48.540	-2.366	137.530	1.414	232.580
923	1.401	4.300	-8.743	-22.250	5.014	26.290	-6.814	125.390	2.957	210.340
924	1.769	4.300	-9.317	-30.000	3.591	10.000	-9.329	110.000	5.891	172.000
926	.395	6.200	-0.394	-25.920	.289	63.360	-0.080	135.360	.711	247.650
927	.735	6.200	-3.617	-22.150	.697	41.540	-2.014	124.620	1.526	227.080
928	1.170	6.200	-5.994	-16.620	4.483	22.150	-3.834	124.620	3.023	232.620
929	1.724	6.200	-5.571	-19.530	8.774	11.160	-4.994	114.420	3.511	209.300
930	2.343	6.200	-7.714	-16.740	13.629	11.160	-5.143	106.050	3.600	209.300
1001	.264	1.440	-0.331	0	.306	192.000	0	0	0	0
1002	.354	1.440	-0.669	0	.500	180.000	0	0	0	0
1003	.490	1.440	-0.837	0	.780	180.000	0	0	0	0
1004	.612	1.440	-0.946	0	1.140	186.000	0	0	0	0
1005	.980	1.440	-1.503	0	1.891	186.000	0	0	0	0
1006	.316	2.130	-0.609	0	.497	194.190	0	0	0	0
1007	.467	2.130	-0.883	0	.826	180.000	0	0	0	0
1008	.626	2.130	-1.034	0	1.231	188.370	0	0	0	0
1009	.948	2.130	-1.690	0	1.720	190.340	0	0	0	0
1010	1.524	2.130	-2.149	0	2.149	219.310	0	0	0	0
1011	.316	2.820	-0.440	0	.383	200.350	0	0	0	0
1012	.587	2.820	-0.811	0	.700	203.480	0	0	0	0
1013	1.058	2.820	-0.791	0	.791	242.070	0	0	0	0
1014	1.442	2.820	-1.200	15.650	.329	125.220	-0.054	175.300	.709	250.430
1015	1.932	2.820	-1.403	18.460	.271	120.000	-0.594	175.380	1.566	270.770
1016	.512	3.550	-0.474	7.400	.500	212.050	0	0	0	0
1017	.993	3.550	-0.609	24.160	-0.054	108.720	-0.331	176.380	.223	251.280
1018	1.469	3.550	-1.157	-12.160	.111	82.700	-0.826	158.110	.771	274.860
1019	2.095	3.550	-3.163	-24.160	-0.163	82.150	-1.909	147.380	1.746	236.780
1020	2.640	3.550	-9.137	-12.330	.831	49.320	-1.937	120.820	4.431	253.970
1021	.476	4.300	-0.420	0	.251	176.950	0	0	0	0
1022	.312	4.300	-0.560	-8.180	.111	81.820	-0.251	182.050	.280	257.950
1023	1.306	4.300	-3.471	-28.800	.826	45.260	-1.929	133.710	1.103	255.090
1024	1.759	4.300	-6.669	-22.250	2.920	32.360	-5.069	121.350	3.911	214.380
1025	2.111	4.300	-7.891	-26.150	6.091	26.150	-6.369	102.570	5.537	183.020
1026	.408	6.200	-0.363	0	.111	249.230	0	0	0	0
1027	.721	6.200	-1.140	-28.350	.140	59.530	-0.363	130.390	.640	260.790
1028	1.127	6.200	-3.546	-16.740	1.091	41.860	-1.691	139.530	2.071	259.530
1029	1.577	6.200	-3.305	0	1.374	42.190	-2.314	120.940	1.654	227.810
1030	2.144	6.200	-6.111	11.080	-0.426	66.460	-2.131	119.080	1.706	283.000
1102	.418	1.440	-1.054	12.410	.811	180.000	0	0	0	0
1103	.503	1.440	-1.209	6.100	1.183	189.150	0	0	0	0
1104	.580	1.440	-1.583	0	1.637	188.850	0	0	0	0
1105	.325	1.440	-1.274	0	3.700	186.000	0	0	0	0
1106	.340	2.130	-0.751	0	1.020	197.140	0	0	0	0
1107	.463	2.130	-1.309	20.000	.989	200.000	0	0	0	0
1108	.593	2.130	-1.729	20.450	1.403	192.270	0	0	0	0
1109	.956	2.130	-2.323	8.090	2.051	194.160	0	0	0	0
1110	1.562	2.130	-2.511	0	2.511	210.340	0	0	0	0
1111	.323	2.820	-0.537	9.080	.697	184.540	0	0	0	0
1112	.701	2.820	-1.017	12.000	1.017	204.000	0	0	0	0
1113	1.034	2.820	-1.257	12.410	.629	232.760	0	0	0	0

VERTICAL FORCES AND PHASES (CONTINUED)

1114	1.469	2.820	-0.503	45.380	1.131	254.120	0	0	0	0
1115	1.366	2.820	-2.829	18.620	1.671	127.240	.771	211.030	2.314	260.690
1116	.544	3.550	-0.749	0	.509	190.730	0	0	0	0
1117	.983	3.550	-0.823	17.260	0	113.420	-0.360	187.400	.154	266.300
1118	1.455	3.550	-1.311	26.580	.683	106.310	-0.734	186.040	.420	289.930
1119	2.095	3.550	-4.766	26.940	3.866	112.650	-2.277	188.570	1.640	323.270
1120	2.694	3.550	-7.291	22.040	7.331	102.860	-2.294	191.020	3.374	328.160
1121	.495	4.300	-0.714	8.280	.383	142.760	0	0	0	0
1122	.302	4.300	-0.514	16.270	.411	109.830	-0.283	170.850	.309	274.580
1123	1.388	4.300	-2.214	29.830	1.891	115.360	-1.351	212.820	.917	322.210
1124	1.778	4.300	-3.360	28.310	3.471	165.170	-2.754	194.160	.826	283.150
1125	2.144	4.300	-5.400	0	2.077	102.570	-0.831	205.140	2.354	283.580
1126	.412	6.200	-0.354	13.740	.230	230.840	0	0	0	0
1127	.721	6.200	-0.891	-11.250	.483	261.560	0	0	0	0
1128	1.197	6.200	-1.400	8.500	0	124.720	-0.251	158.740	.300	277.800
1129	1.587	6.200	-3.483	5.630	.706	59.060	-0.403	120.940	2.977	241.880
1130	2.150	6.200	-5.289	-13.950	-0.274	50.230	-1.543	97.670	1.929	287.440
1207	.700	2.577	-0.194	68.570	.689	209.140	0	0	0	0
1208	1.024	2.577	-0.357	77.380	1.157	198.500	.497	326.360	0	0
1210	1.905	2.577	-1.003	74.720	3.174	193.580	1.057	292.080	1.503	343.020
1212	1.034	3.420	-0.394	83.080	1.406	191.330	.506	279.440	.843	347.410
1213	1.508	3.420	-0.437	79.450	3.000	186.210	1.037	268.140	2.129	342.620
1214	2.101	3.420	-0.654	71.490	5.400	173.620	-1.691	257.870	4.746	342.130
1217	.925	4.304	-0.271	81.100	1.351	193.850	.377	272.970	1.134	350.110
1218	1.508	4.304	-0.271	73.190	3.763	181.980	1.037	270.990	3.491	342.200
1219	2.047	4.304	-0.946	61.320	6.346	156.260	.540	257.140	6.480	332.310
1227	.762	6.200	-0.137	74.200	.829	192.370	.111	280.310	.691	343.510
1228	1.017	6.200	-0.111	67.500	1.494	194.060	.389	275.630	1.689	351.560
1302	.517	1.746	-0.191	10.140	.246	192.680	0	0	0	0
1303	.762	1.746	-0.383	14.790	.246	197.260	0	0	0	0
1304	.889	1.746	-0.329	10.140	.549	187.610	0	0	0	0
1305	1.266	1.746	-0.703	10.000	.600	200.000	0	0	0	0
1306	.350	2.577	-0.243	0	.243	213.330	0	0	0	0
1307	.646	2.577	-1.069	-17.140	-0.106	82.290	-0.349	147.430	.294	243.430
1308	1.007	2.577	-2.077	-27.690	-0.194	72.690	-1.080	141.920	.691	238.850
1309	1.714	2.577	-4.954	-36.670	.111	50.000	-3.563	123.330	2.171	223.330
1310	1.986	2.577	-6.646	-43.330	.554	43.330	-5.263	126.670	3.600	216.670
1311	.490	3.420	-0.729	-20.140	.030	75.520	-0.323	143.500	.406	234.130
1312	1.072	3.420	-3.446	-40.850	.406	51.060	-2.740	130.210	1.737	227.230
1313	1.481	3.420	-6.171	-49.660	1.874	27.310	-5.346	111.720	3.857	206.070
1314	2.150	3.420	-9.554	-65.000	5.263	20.000	-8.723	95.000	7.200	187.500
1315	3.232	3.420	-12.420	-76.600	9.720	-7.660	-10.531	86.810	13.771	176.170
1316	.490	4.304	-1.069	-38.640	-0.030	63.050	-0.509	130.170	.374	229.830
1317	.316	4.304	-3.520	-54.300	.860	28.160	-2.551	110.610	2.177	211.170
1318	1.524	4.304	-6.654	-54.610	3.600	14.160	-6.109	101.120	5.509	212.360
1319	2.014	4.304	-8.234	-67.620	6.430	0	-6.346	87.510	7.694	184.970
1320	3.071	4.304	-7.560	-61.320	11.340	-7.910	-10.260	79.120	11.611	168.130
1321	.377	5.210	-0.954	-43.740	-0.030	50.470	-0.529	119.440	.529	217.010
1322	.700	5.210	-2.526	-46.670	.746	26.670	-2.023	103.330	1.834	226.670
1323	1.116	5.210	-3.917	-63.330	2.700	10.000	-3.811	93.330	3.706	203.330
1324	1.469	5.210	-4.743	-52.840	4.609	6.610	-5.794	79.270	4.874	198.170
1325	2.330	5.210	-8.100	-56.670	12.420	-13.330	-10.531	73.330	10.800	156.670
1326	.327	6.200	-0.626	-47.210	-0.077	59.020	-0.286	126.890	.366	224.260
1327	.680	6.200	-2.000	-54.290	.459	22.860	-1.506	108.570	1.557	214.290
1328	1.007	6.200	-3.169	-55.810	1.557	13.950	-2.803	94.880	2.700	217.670
1329	1.481	6.200	-4.454	-50.630	3.914	5.630	-4.320	87.100	4.454	219.380
1330	3.071	6.200	-8.371	-41.860	15.931	-8.370	-5.671	75.350	5.400	153.490
1401	.296	1.746	-0.183	0	.106	177.530	0	0	0	0
1402	.512	1.746	-0.206	0	.206	175.000	0	0	0	0
1403	.735	1.746	-0.463	15.000	.257	185.000	0	0	0	0
1404	.980	1.746	-0.354	0	.523	180.000	0	0	0	0
1405	1.252	1.746	-0.717	10.000	.446	190.000	0	0	0	0
1406	.323	2.577	-0.166	0	.223	188.260	0	0	0	0
1407	.546	2.577	-0.417	0	.474	201.870	0	0	0	0
1408	.397	2.577	-0.763	0	.491	210.000	0	0	0	0
1409	1.497	2.577	-1.689	0	.674	228.790	0	0	0	0
1410	1.939	2.577	-3.031	-16.820	-0.220	84.110	-0.497	131.210	1.431	232.150
1411	.485	3.420	-0.331	0	.331	162.970	0	0	0	0
1412	1.007	3.420	-1.446	-12.860	.546	226.290	0	0	0	0
1413	1.463	3.420	-4.126	-25.170	.514	50.350	-2.551	146.010	1.520	236.640
1414	2.095	3.420	-8.294	-27.890	3.063	35.490	-6.069	131.830	6.183	212.360
1415	2.776	3.420	-16.483	-37.760	8.243	17.620	-10.810	125.360	11.937	193.350
1416	.381	4.304	-0.457	0	.134	182.000	0	0	0	0
1417	.343	4.304	-2.194	-28.310	.054	66.740	-0.906	137.530	1.097	240.570
1418	1.497	4.304	-7.237	-28.160	2.394	34.190	-4.454	130.730	4.509	235.310
1419	1.386	4.304	-10.800	-44.250	5.814	16.090	-8.169	122.680	6.923	223.130
1420	2.640	4.304	-11.340	-36.610	8.640	6.100	-8.640	117.970	7.291	187.120
1421	.435	5.210	-0.457	0	.109	229.090	0	0	0	0
1422	.762	5.210	-2.089	-23.120	.134	52.840	-1.057	138.720	1.194	231.190
1423	1.212	5.210	-4.849	-26.670	2.040	30.000	-3.646	123.330	3.637	210.000
1424	1.481	5.210	-5.826	-39.630	4.263	16.510	-5.683	108.990	4.974	214.680
1425	2.586	5.210	-7.105	-38.160	15.065	-4.980	-6.251	102.860	9.949	149.310
1427	.680	6.200	-1.294	-19.840	.386	62.360	-0.254	138.900	.957	246.610
1428	1.024	6.200	-3.860	-22.680	.966	36.850	-2.217	136.060	2.160	225.770

VERTICAL FORCES AND PHASES (CONTINUED)

1429	1.528	6.200	-6.569	-31.430	3.357	20.000	-4.377	128.570	3.940	228.570
1430	2.830	6.200	-7.357	-22.680	11.083	5.670	-5.969	99.210	5.400	172.910
1507	.567	2.577	-0.360	10.290	.803	188.570	0	0	0	0
1508	.390	2.577	-0.689	13.460	.826	191.780	0	0	0	0
1510	1.312	2.577	-0.831	13.330	1.109	223.330	0	0	0	0
1512	.990	3.420	-0.580	0	.440	216.500	0	0	0	0
1513	1.401	3.420	-0.717	0	0	111.370	-0.137	170.940	.274	251.220
1514	1.397	3.420	-0.969	0	.403	121.690	-0.294	162.250	.751	238.310
1517	.352	4.304	-0.646	18.310	.111	117.970	-0.111	178.980	.197	254.240
1518	1.497	4.304	-1.357	-32.000	.254	74.000	-0.646	126.000	1.237	244.000
1519	2.062	4.304	-7.660	-26.150	1.709	46.260	-3.417	122.680	4.297	227.260
1527	.567	6.200	-0.583	0	.054	255.940	0	0	0	0
1528	.980	6.200	-0.917	-16.740	-0.111	69.770	-0.417	133.950	.697	259.530
1529	1.388	6.200	-4.174	-14.060	1.003	45.000	-1.949	140.630	2.560	244.690
1530	2.286	6.200	-4.251	-8.500	1.149	41.100	-2.989	136.060	4.251	198.430
1602	.544	1.746	-1.026	15.210	.831	197.750	0	0	0	0
1603	.754	1.746	-1.431	14.790	1.377	192.330	-1.460	369.860	0	0
1604	1.034	1.746	-1.857	20.280	1.911	202.820	0	0	0	0
1605	1.252	1.746	-2.337	0	2.449	187.610	0	0	0	0
1606	.350	2.577	-0.686	20.190	.740	191.780	0	0	0	0
1607	.640	2.577	-1.146	10.090	1.417	188.410	0	0	0	0
1608	1.007	2.577	-1.360	0	1.891	192.000	0	0	0	0
1609	1.587	2.577	-1.909	13.460	2.231	201.870	0	0	0	0
1610	2.014	2.577	-1.874	10.190	2.811	213.960	0	0	0	0
1611	.512	3.420	-1.080	7.450	1.026	183.720	0	0	0	0
1612	1.077	3.420	-1.377	0	1.709	178.720	0	0	0	0
1613	1.497	3.420	-1.309	0	2.129	168.830	0	0	0	0
1614	2.122	3.420	-2.160	0	2.971	161.380	0	0	0	0
1615	2.801	3.420	-7.020	28.090	6.751	130.210	-0.811	214.470	2.160	313.150
1616	.490	4.304	-0.611	-24.270	.969	141.570	0	0	0	0
1617	.343	4.304	-0.520	-30.000	1.920	132.000	0	0	0	0

APPENDIX C

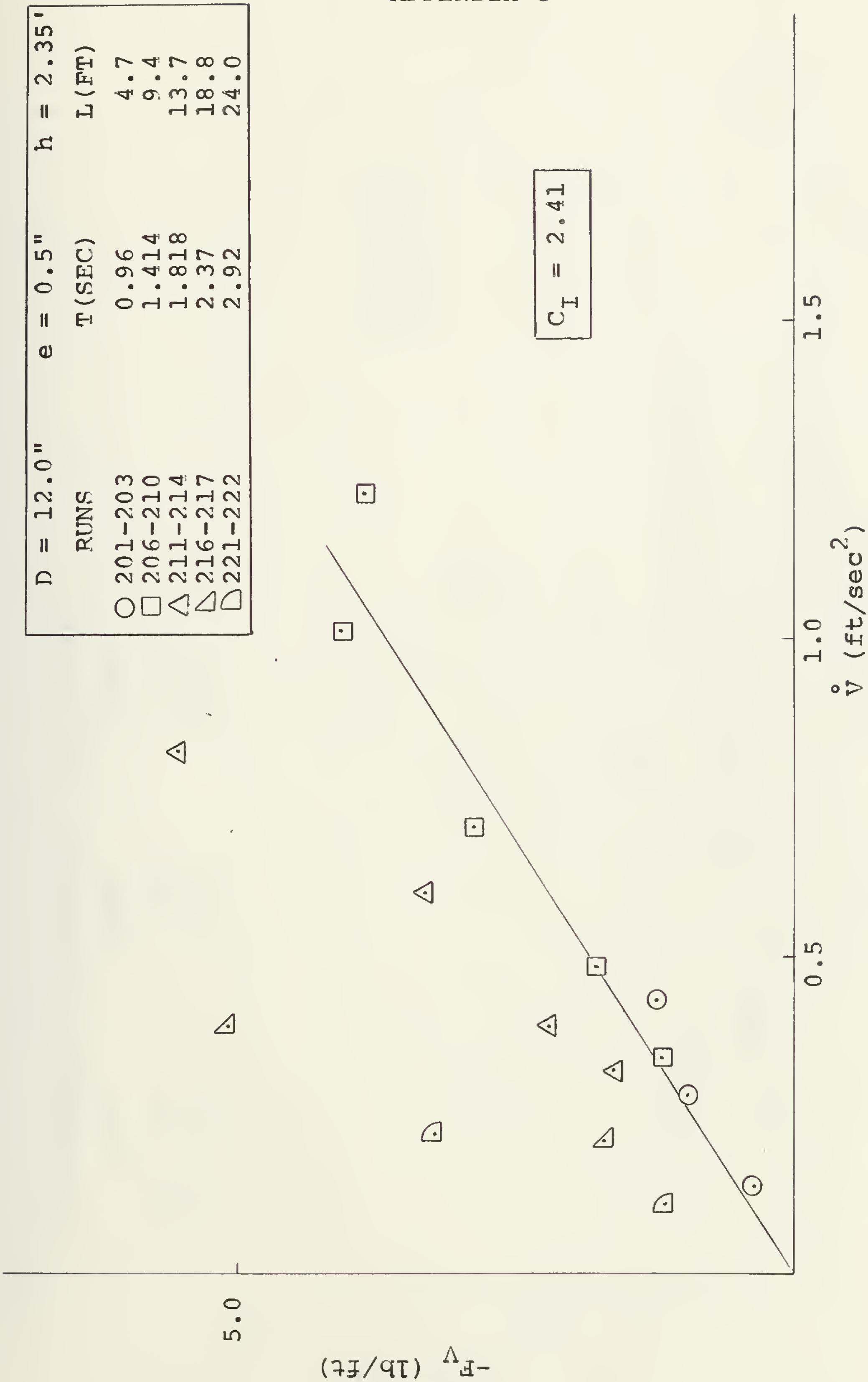

Figure C1. Negative vertical force vs vertical acceleration.

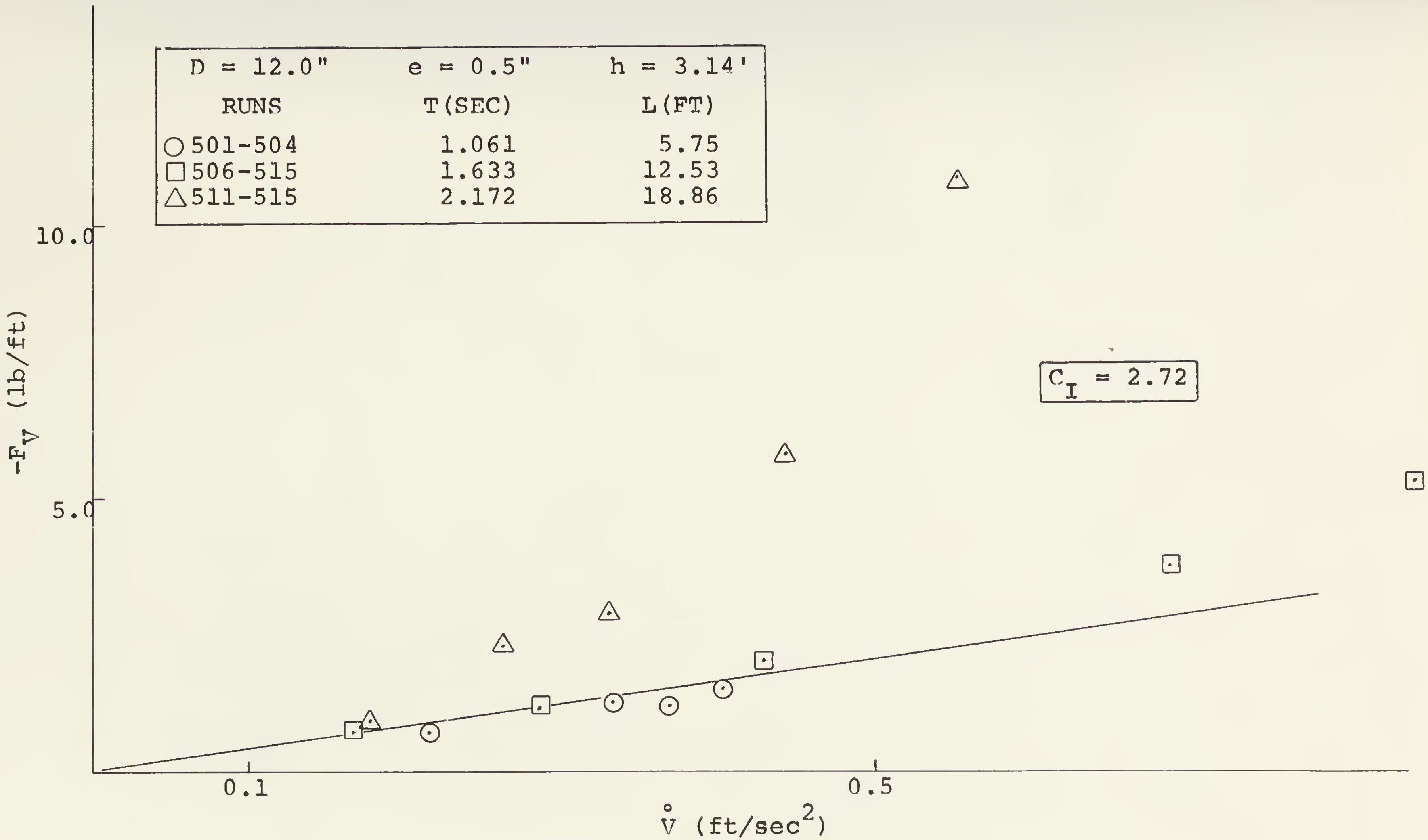

Figure C2. Negative vertical force vs vertical acceleration.

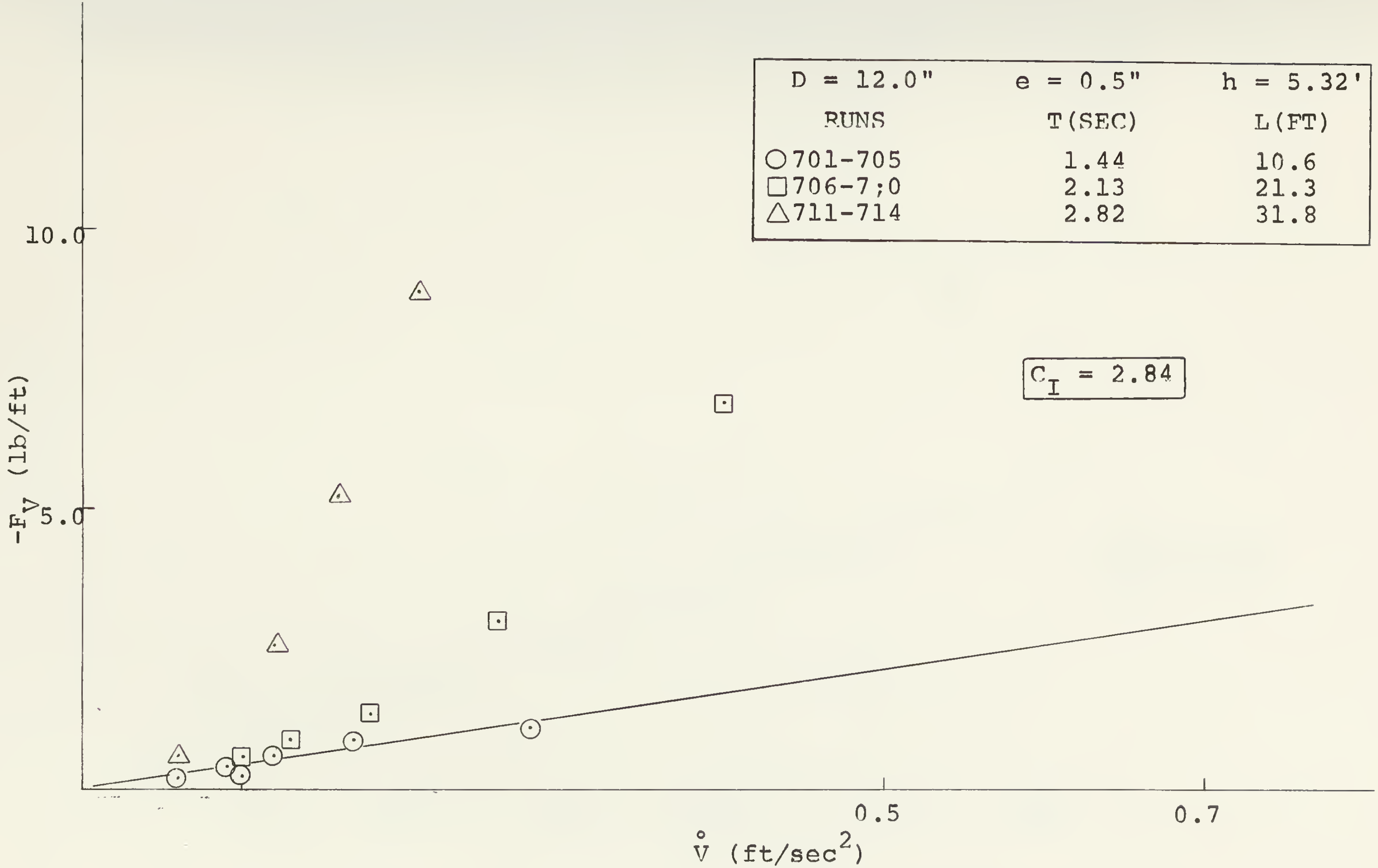

Figure C3. Negative vertical force vs vertical acceleration.

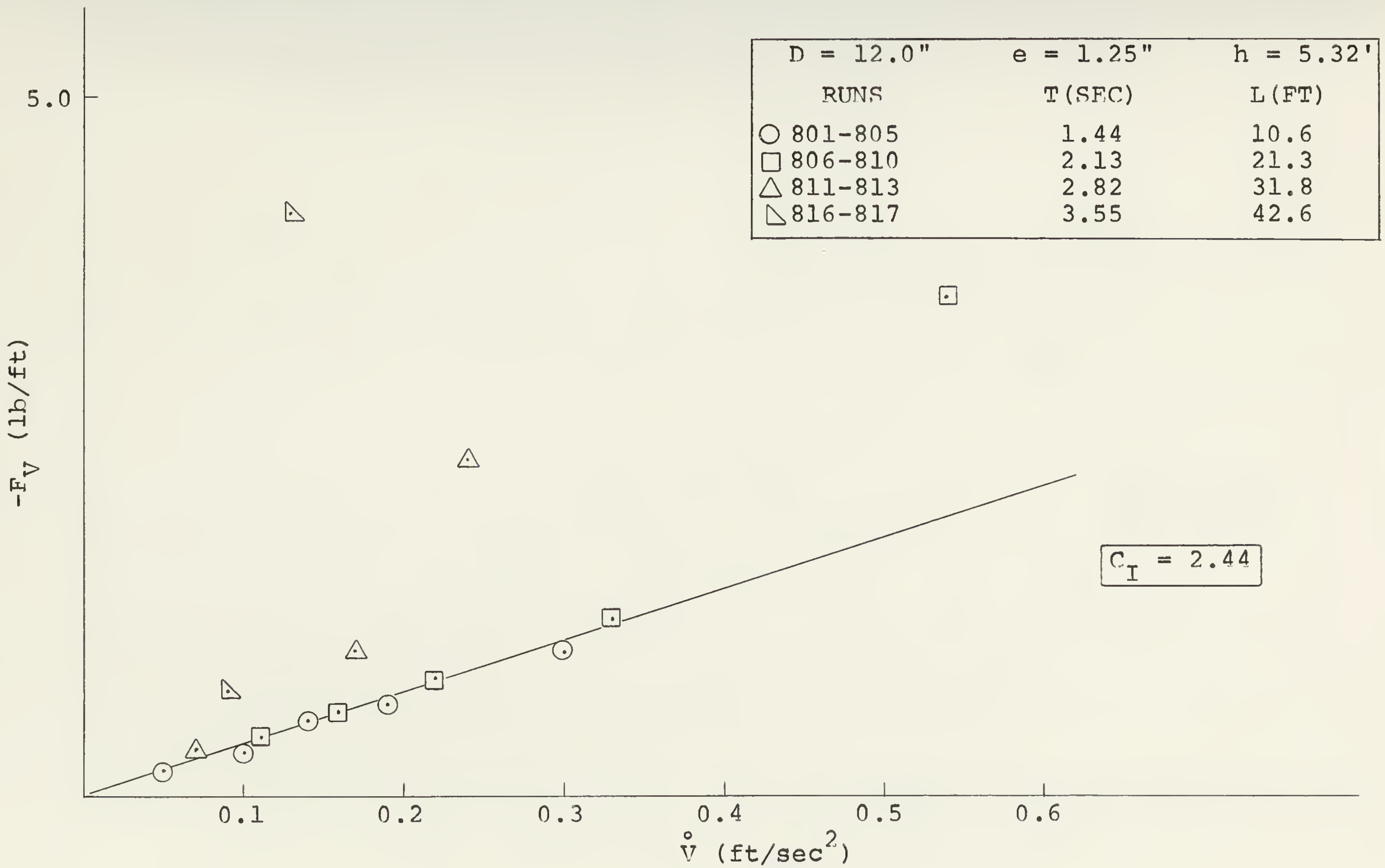

Figure C4. Negative vertical force vs vertical acceleration.

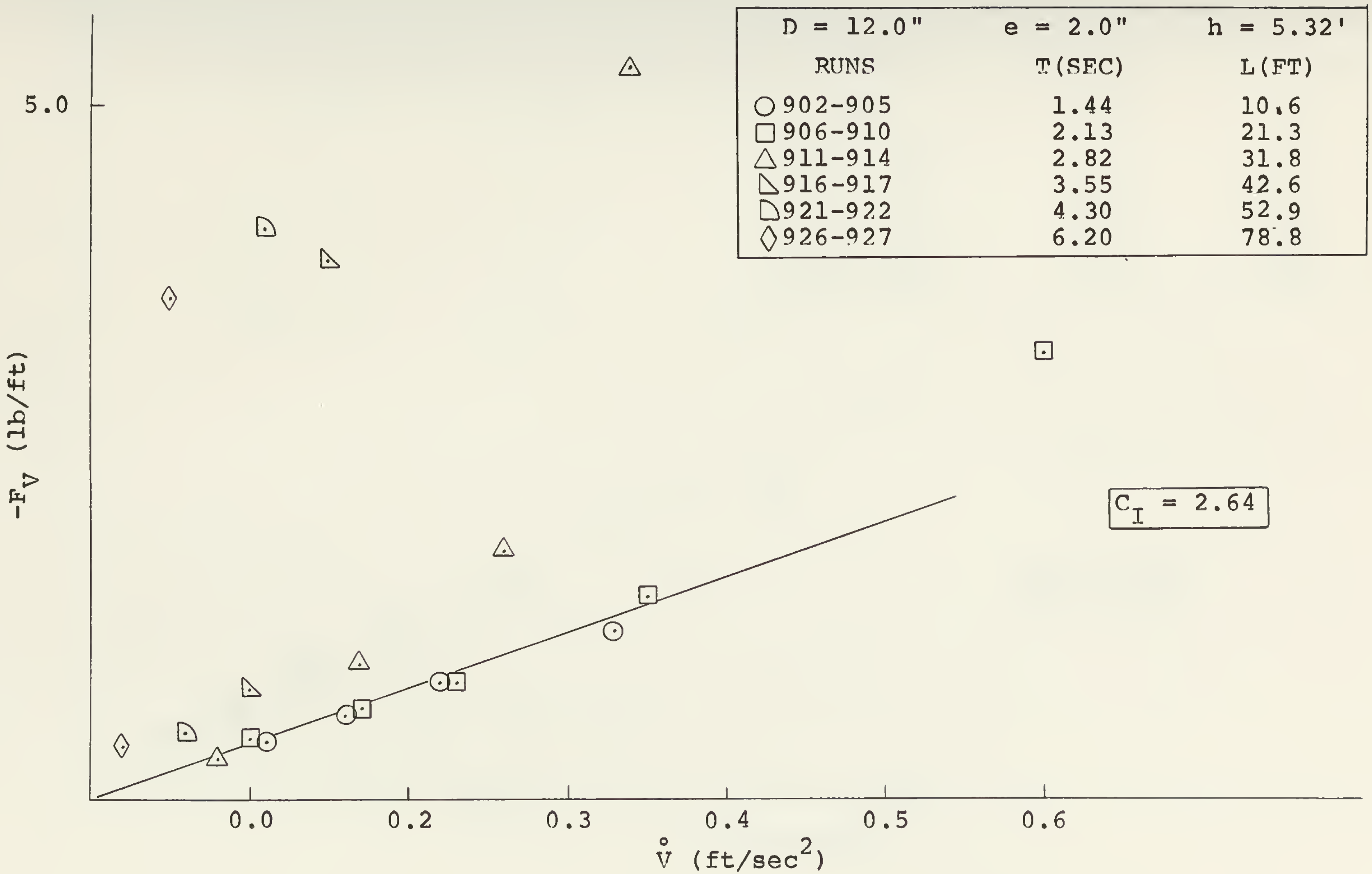

Figure C5. Negative vertical force vs vertical acceleration.

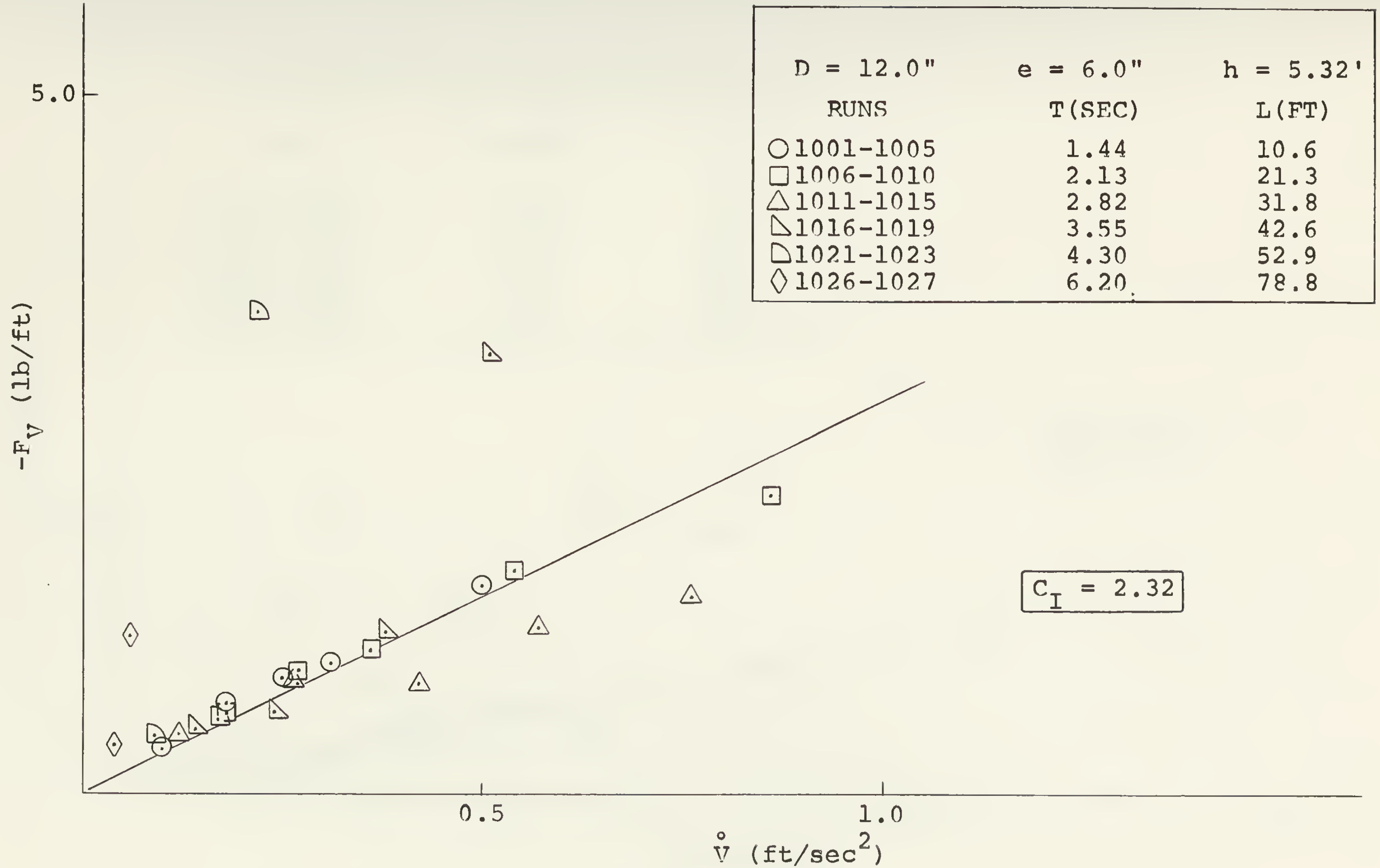

Figure C6. Negative vertical force vs vertical acceleration.

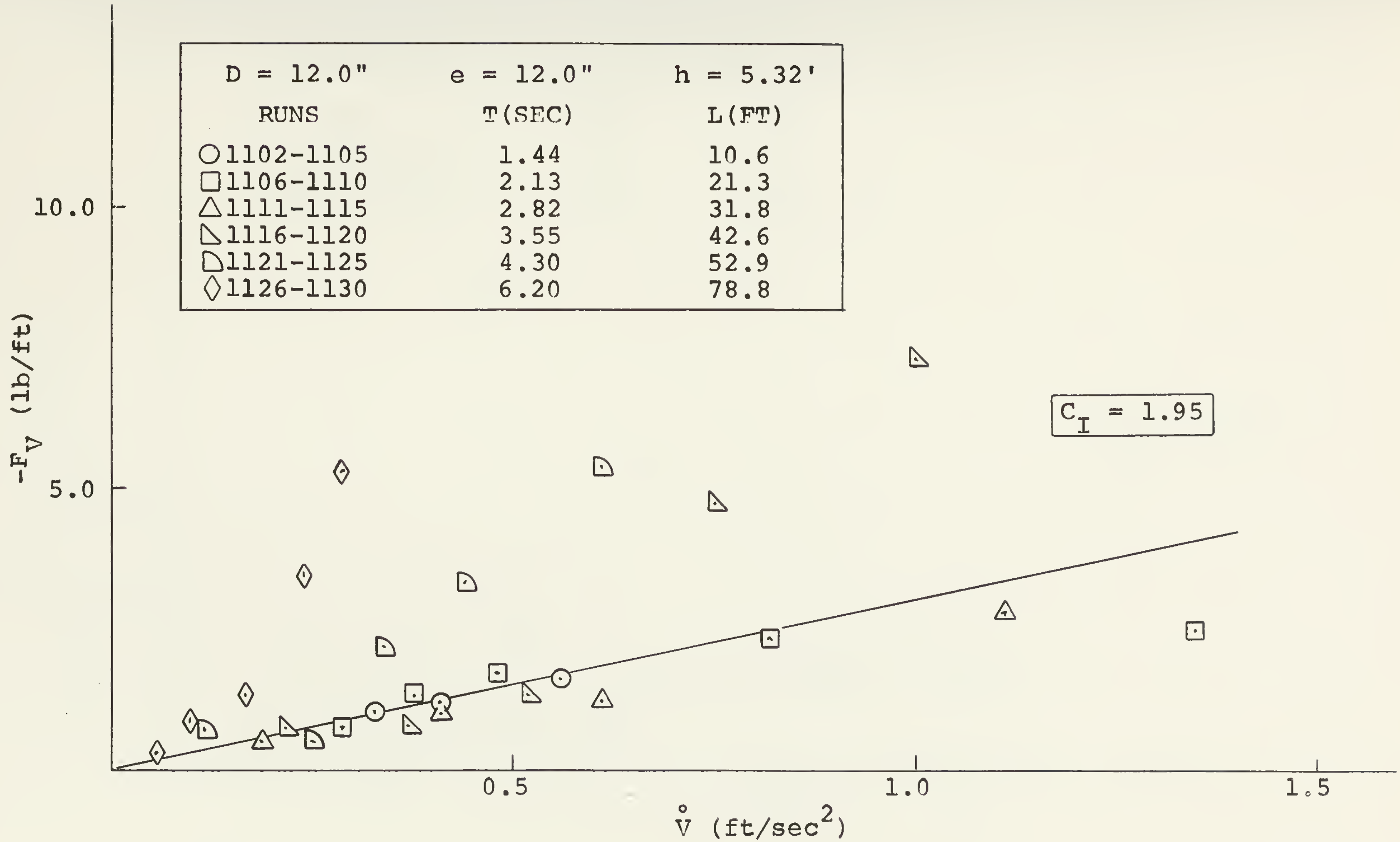

Figure C7. Negative vertical force vs vertical acceleration.

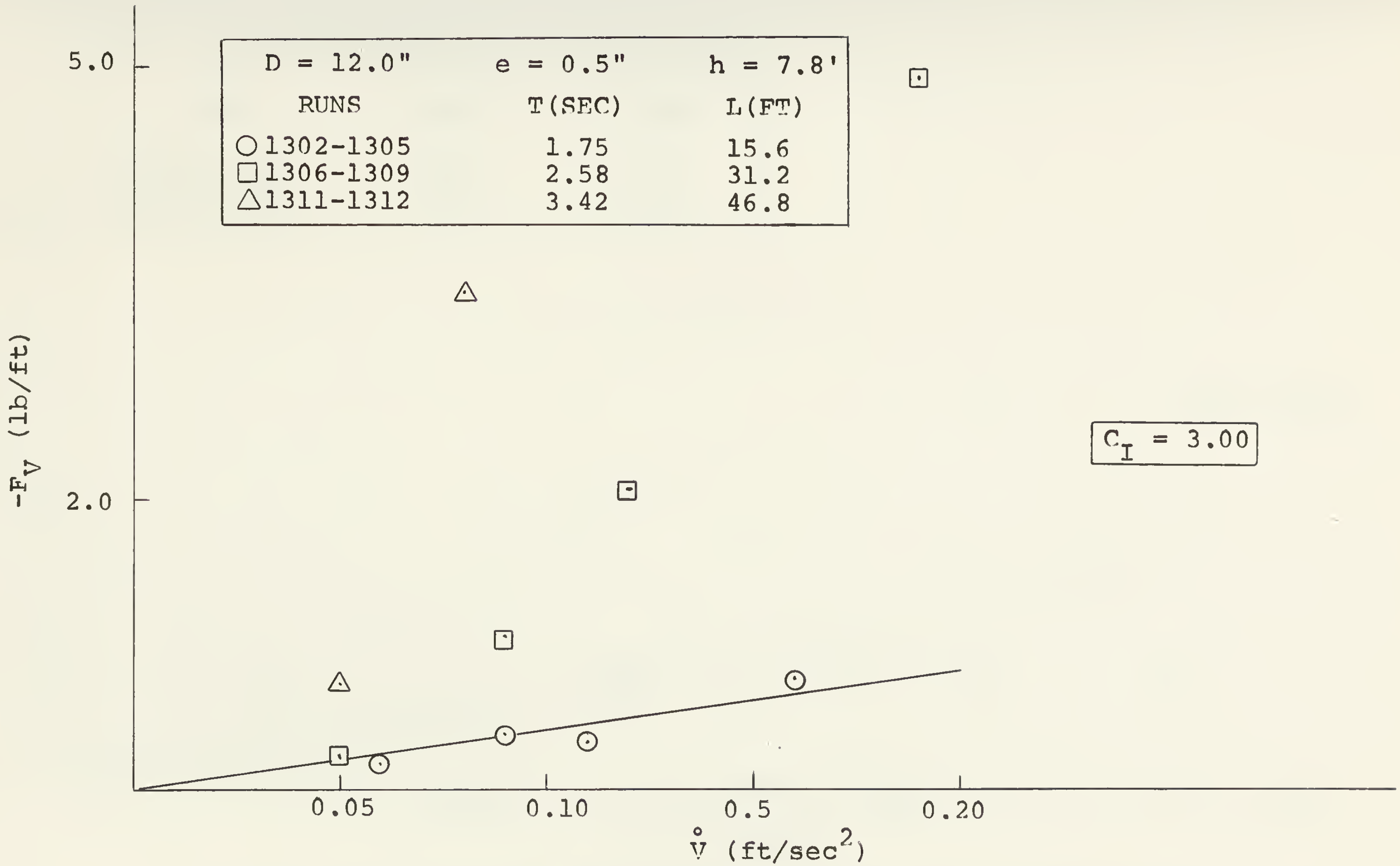

Figure C8. Negative vertical force vs vertical acceleration.

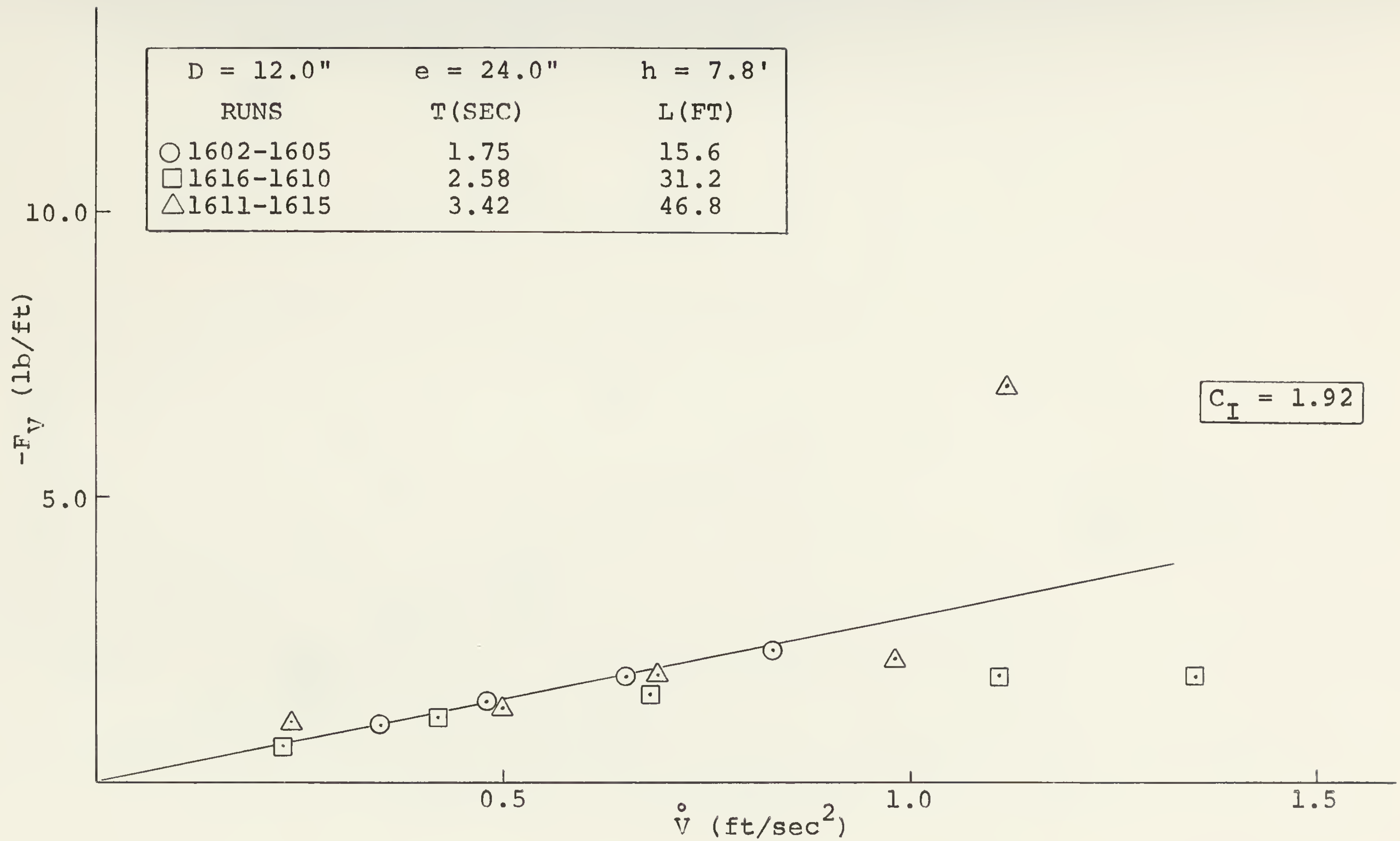

Figure C9. Negative vertical force vs vertical acceleration.

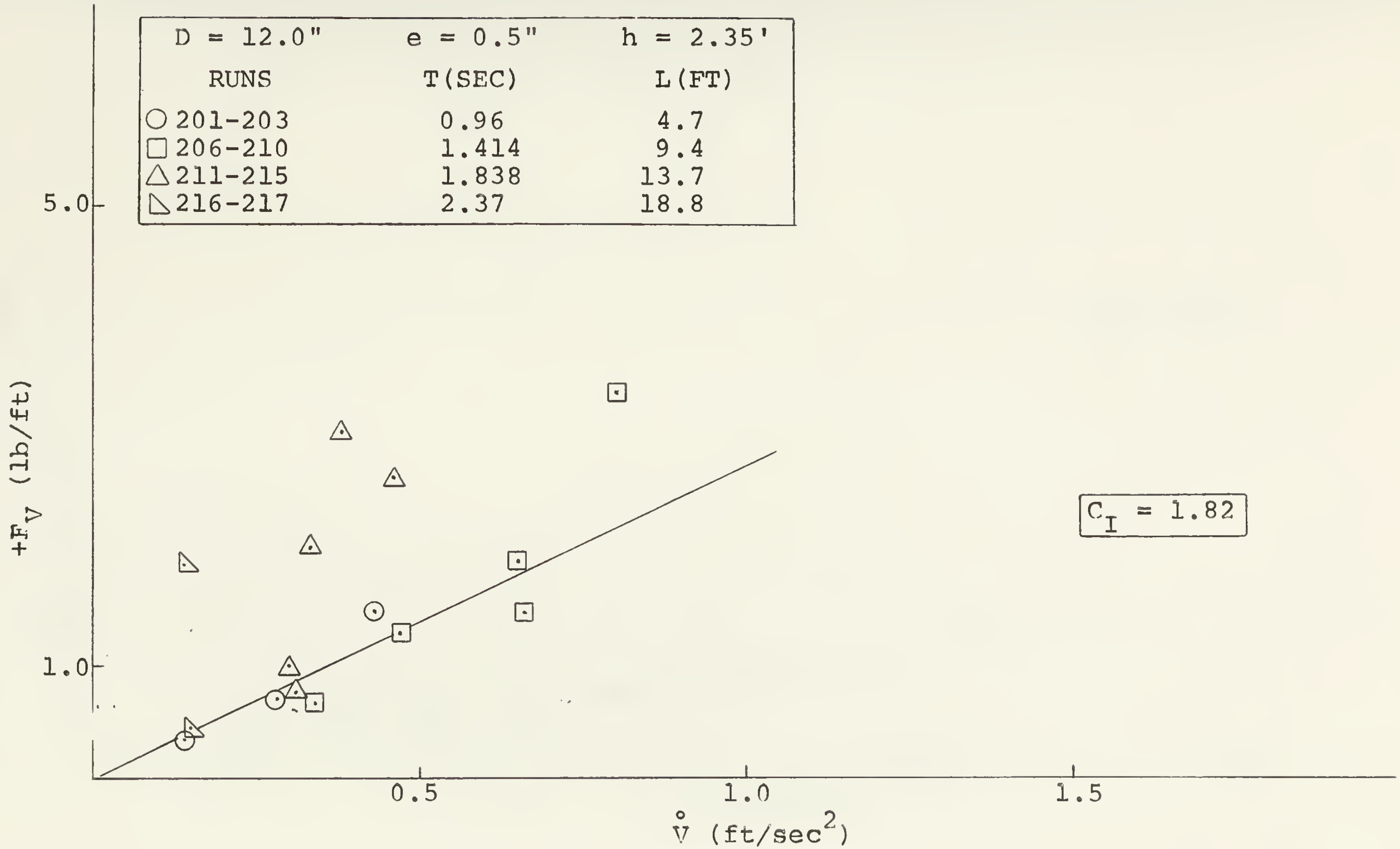

Figure C10. Positive vertical force vs vertical acceleration.

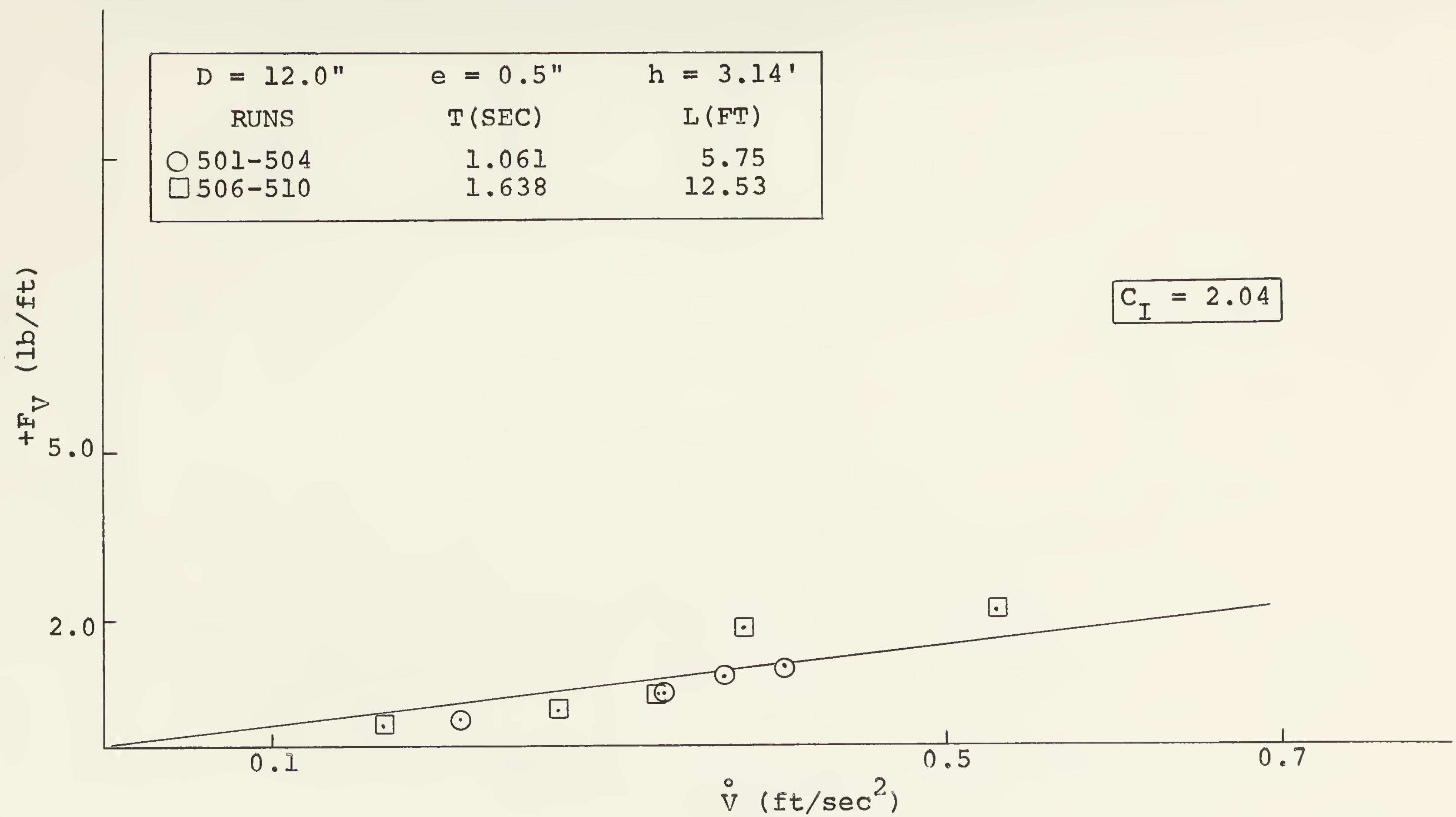

Figure C11. Positive vertical force vs vertical acceleration.

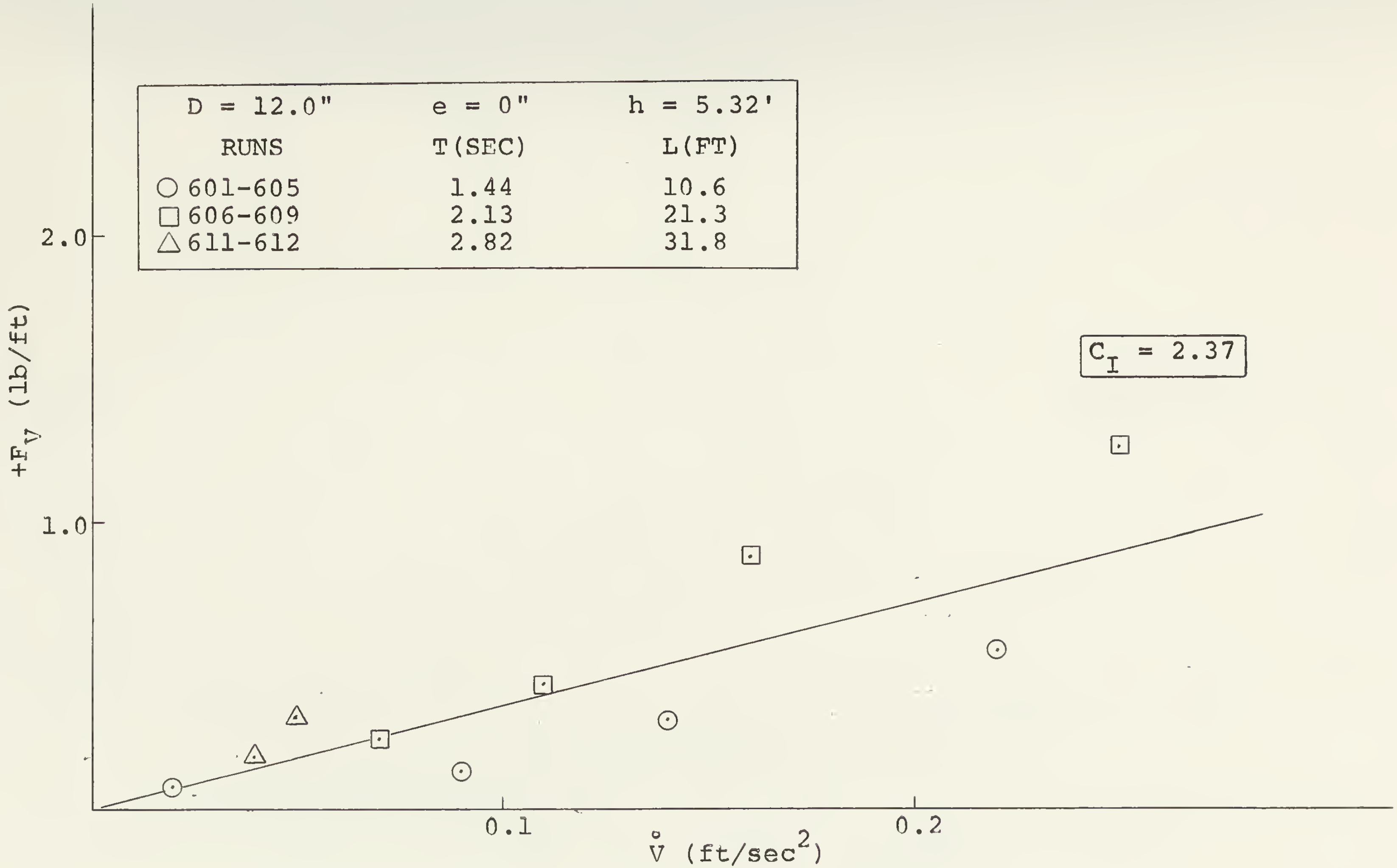

Figure C12. Positive vertical force vs vertical acceleration.

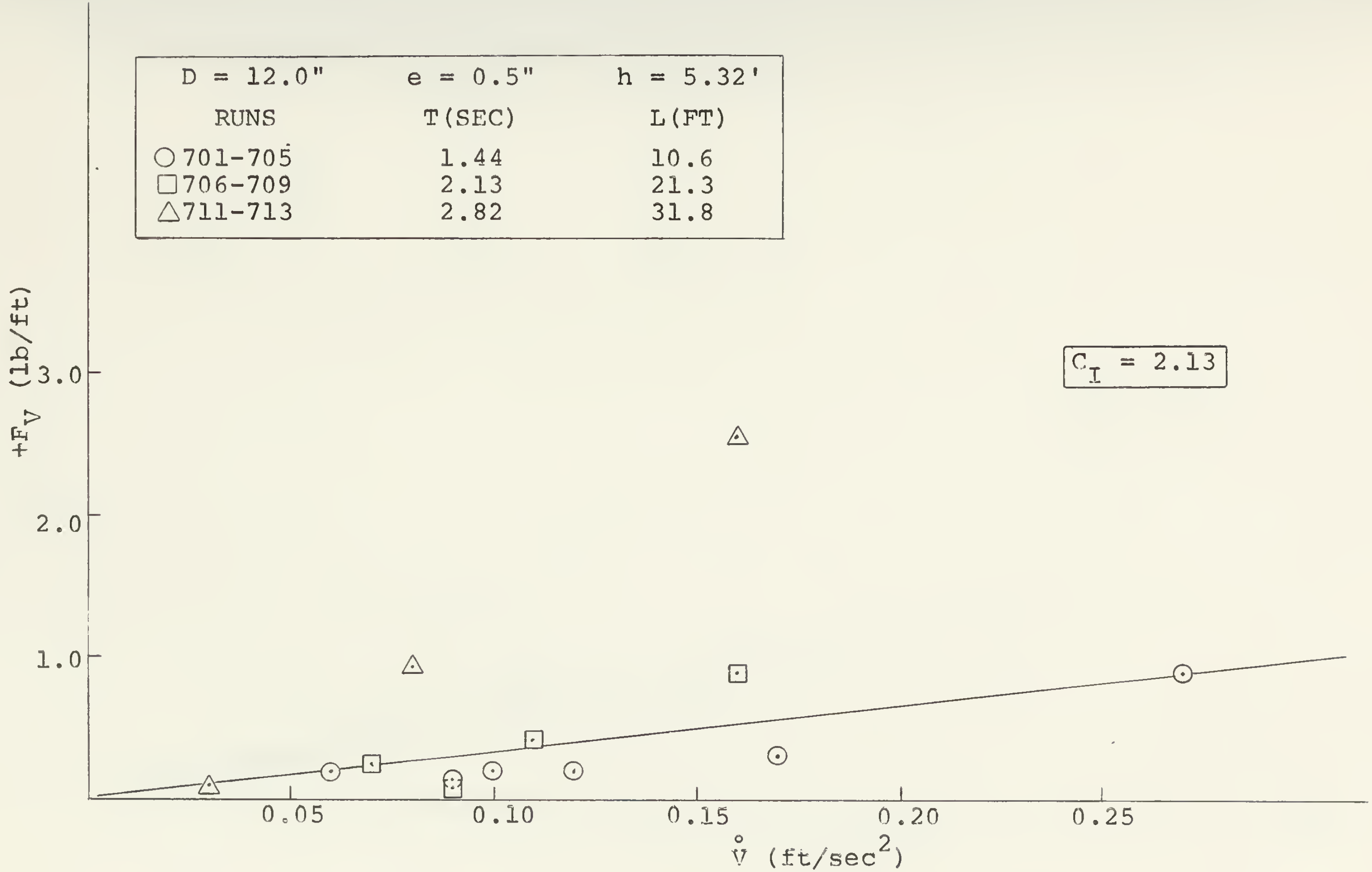

Figure C13. Positive vertical force vs vertical acceleration.

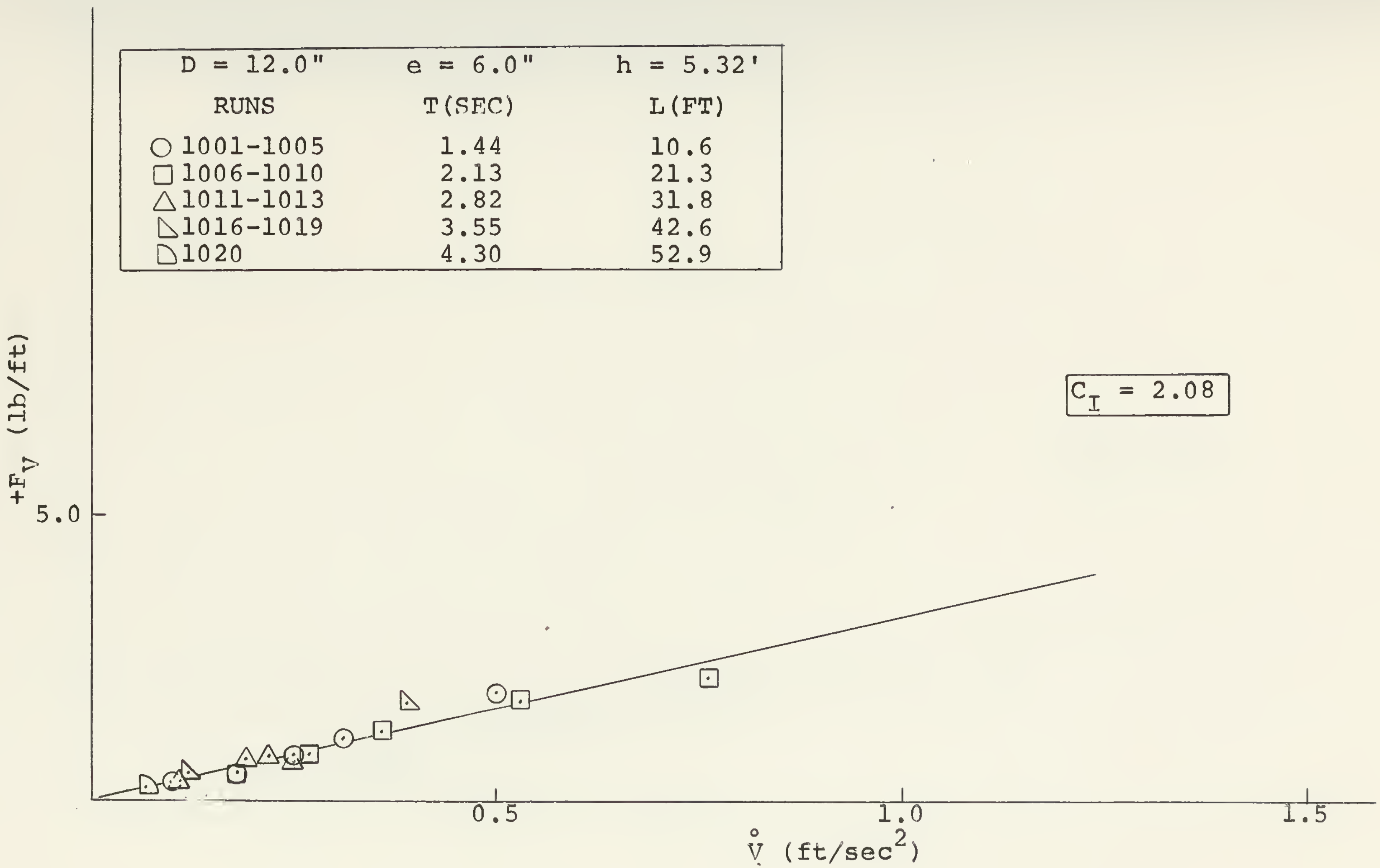

Figure C14. Positive vertical force vs vertical acceleration.

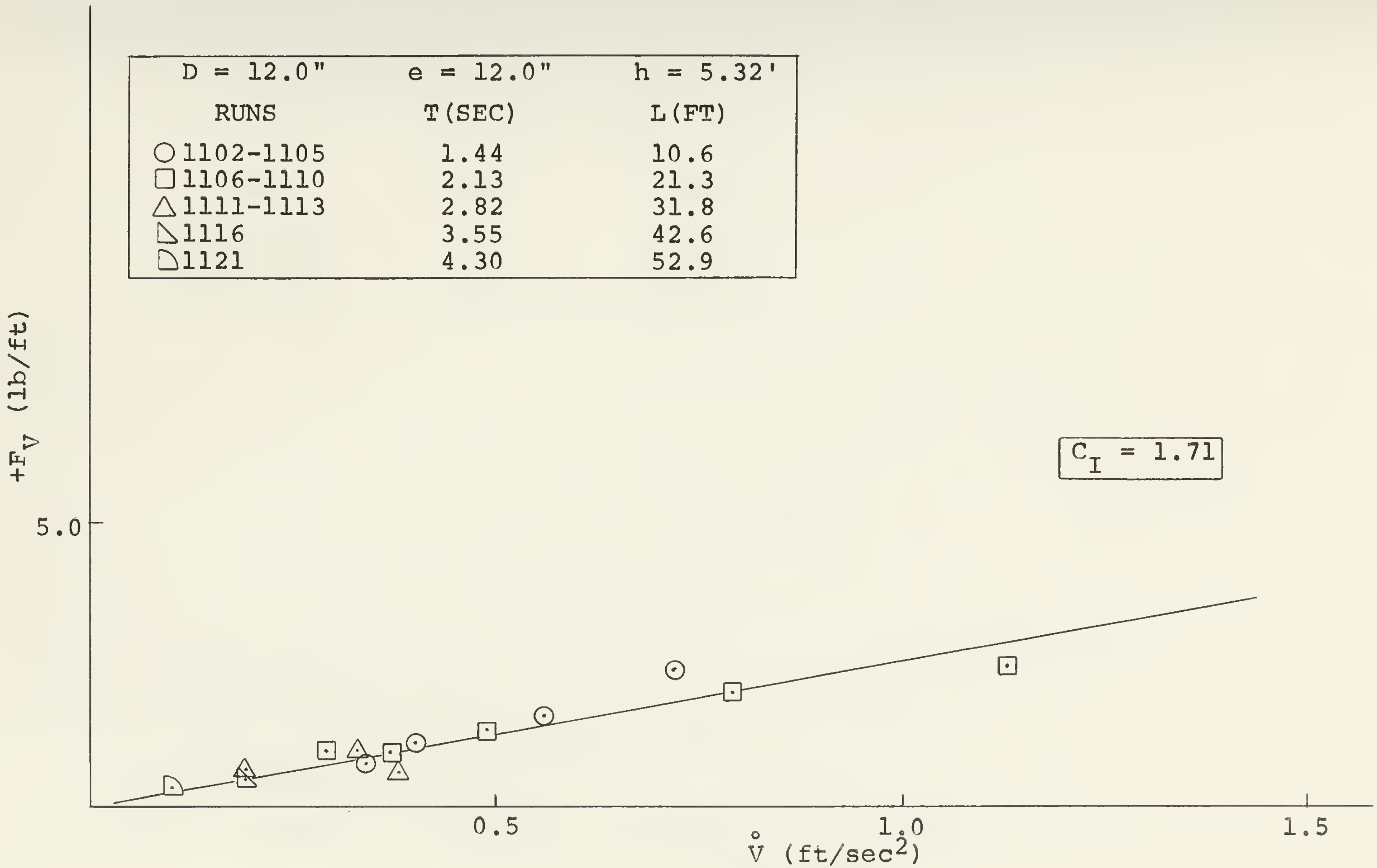

Figure C15. Positive vertical force vs vertical acceleration.

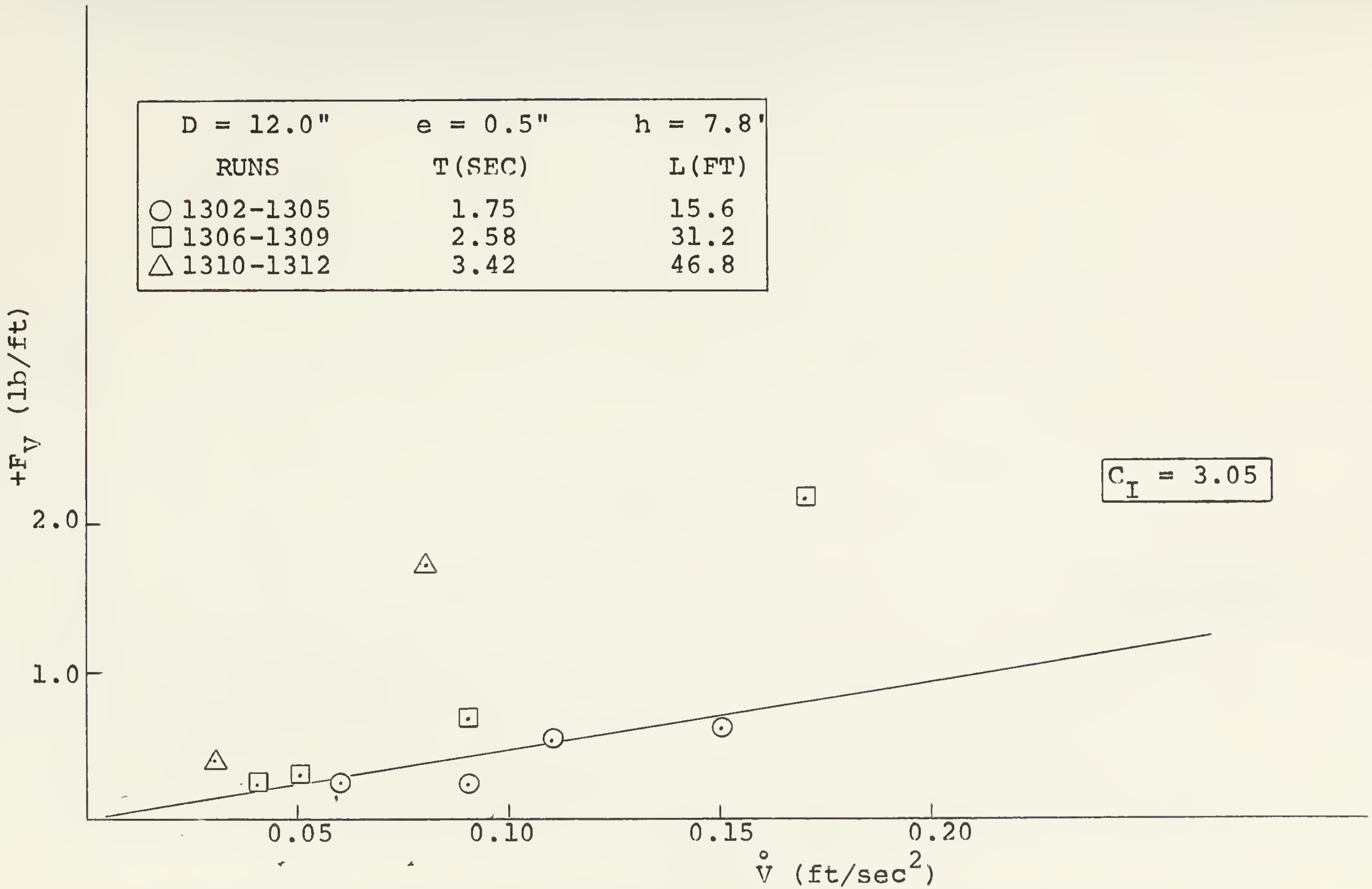

Figure C16. Positive vertical force vs vertical acceleration.

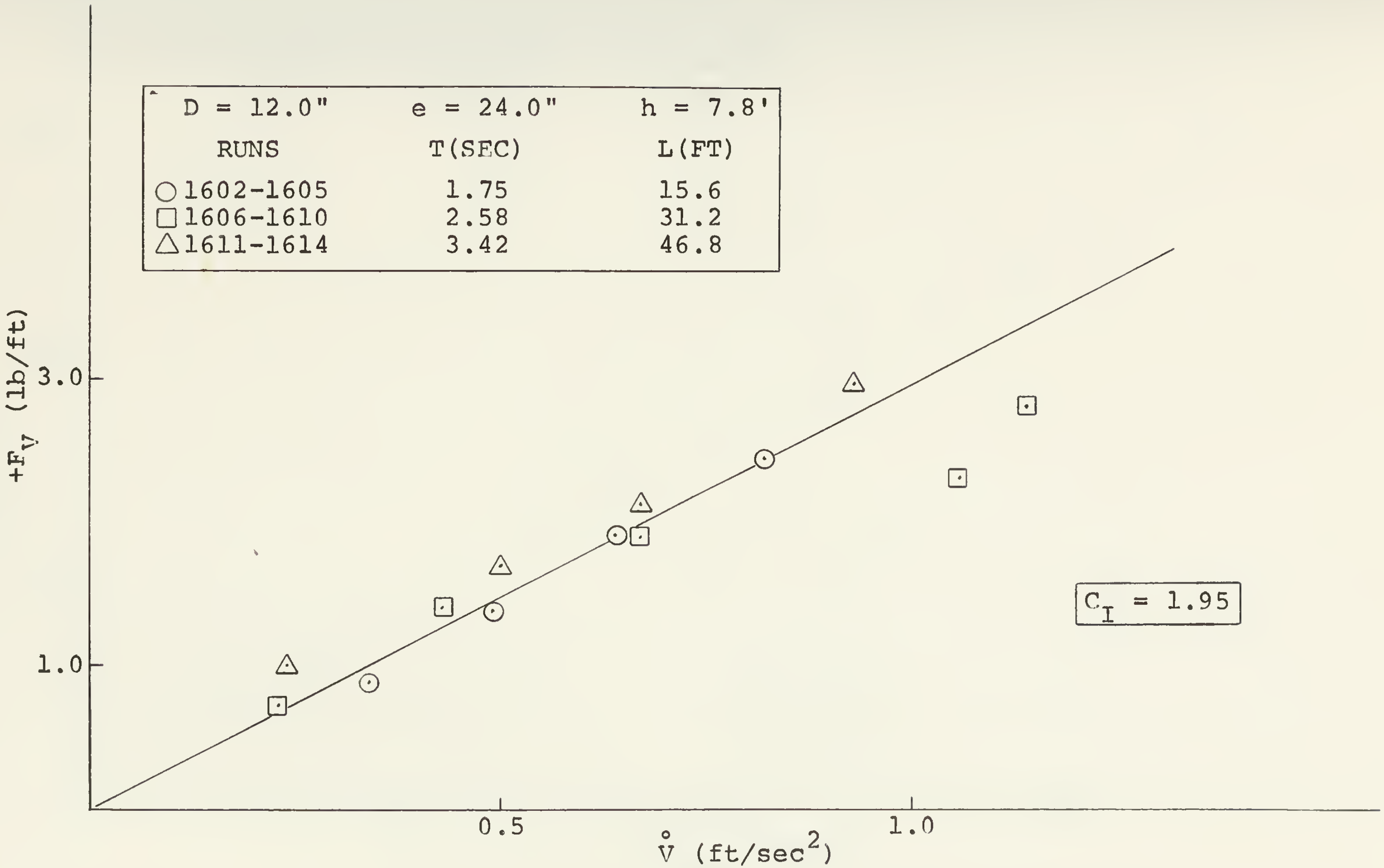

Figure C17. Positive vertical force vs vertical acceleration.

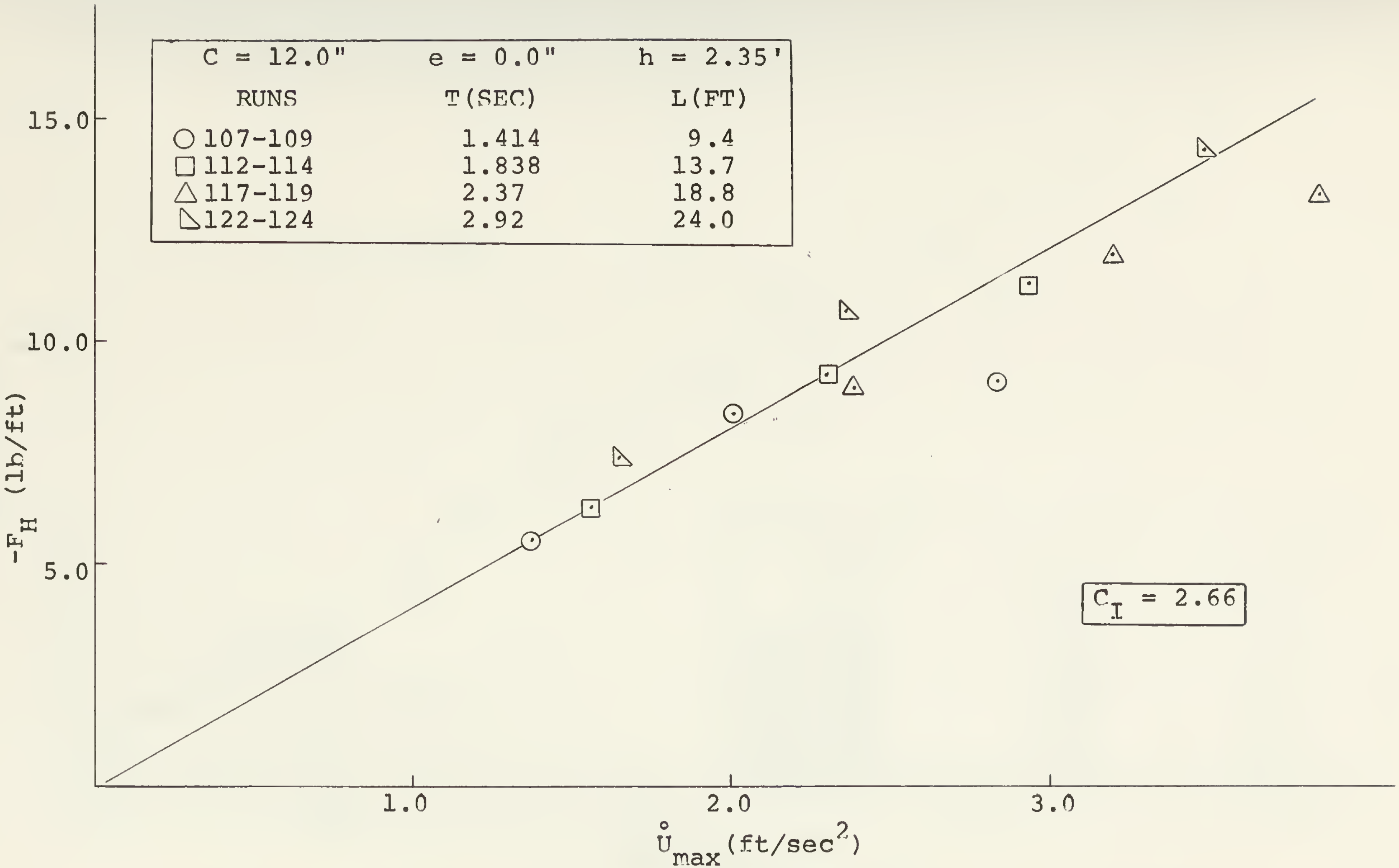

Figure C18. Negative horizontal force vs maximum horizontal acceleration.

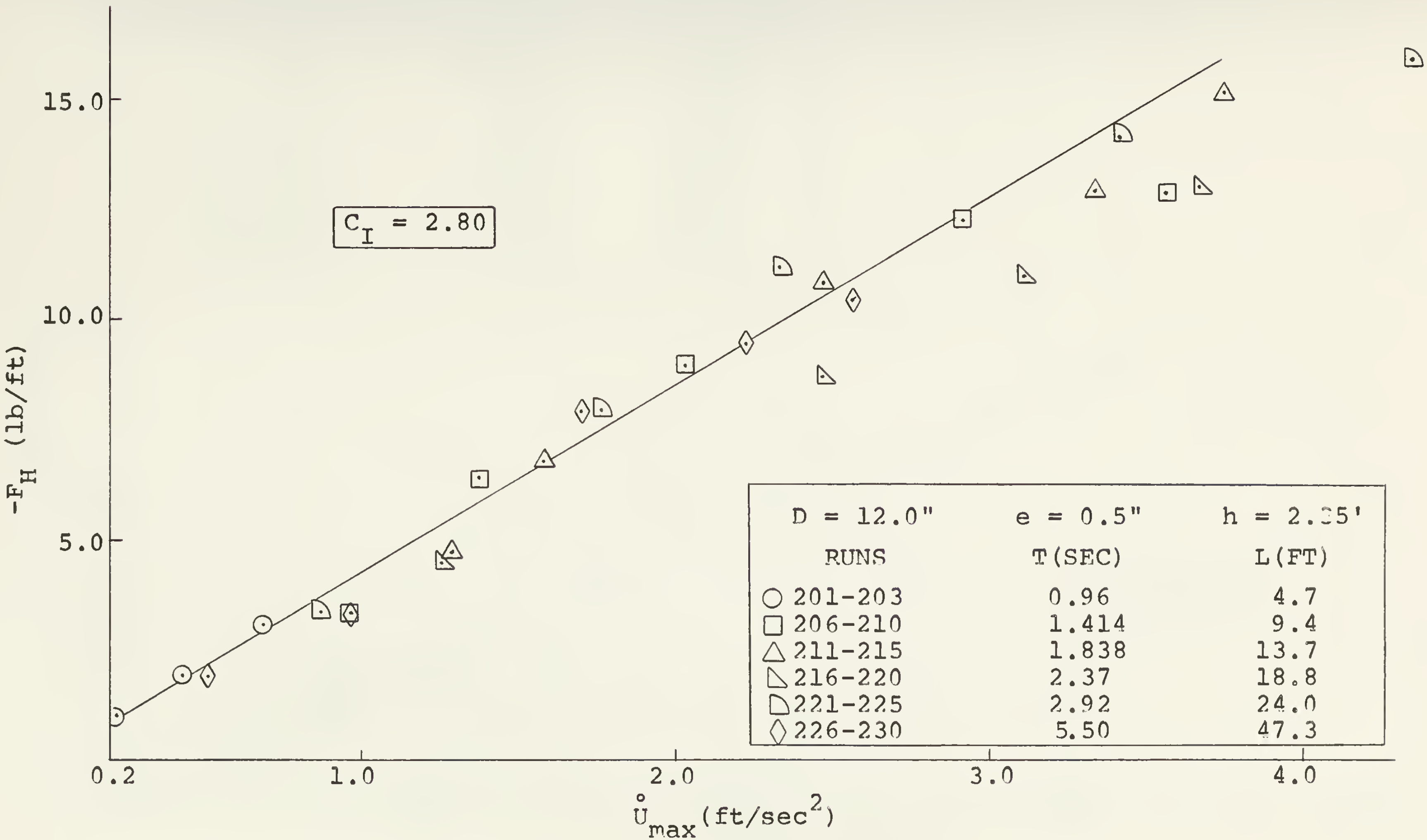

Figure C19. Negative horizontal force vs maximum horizontal acceleration.

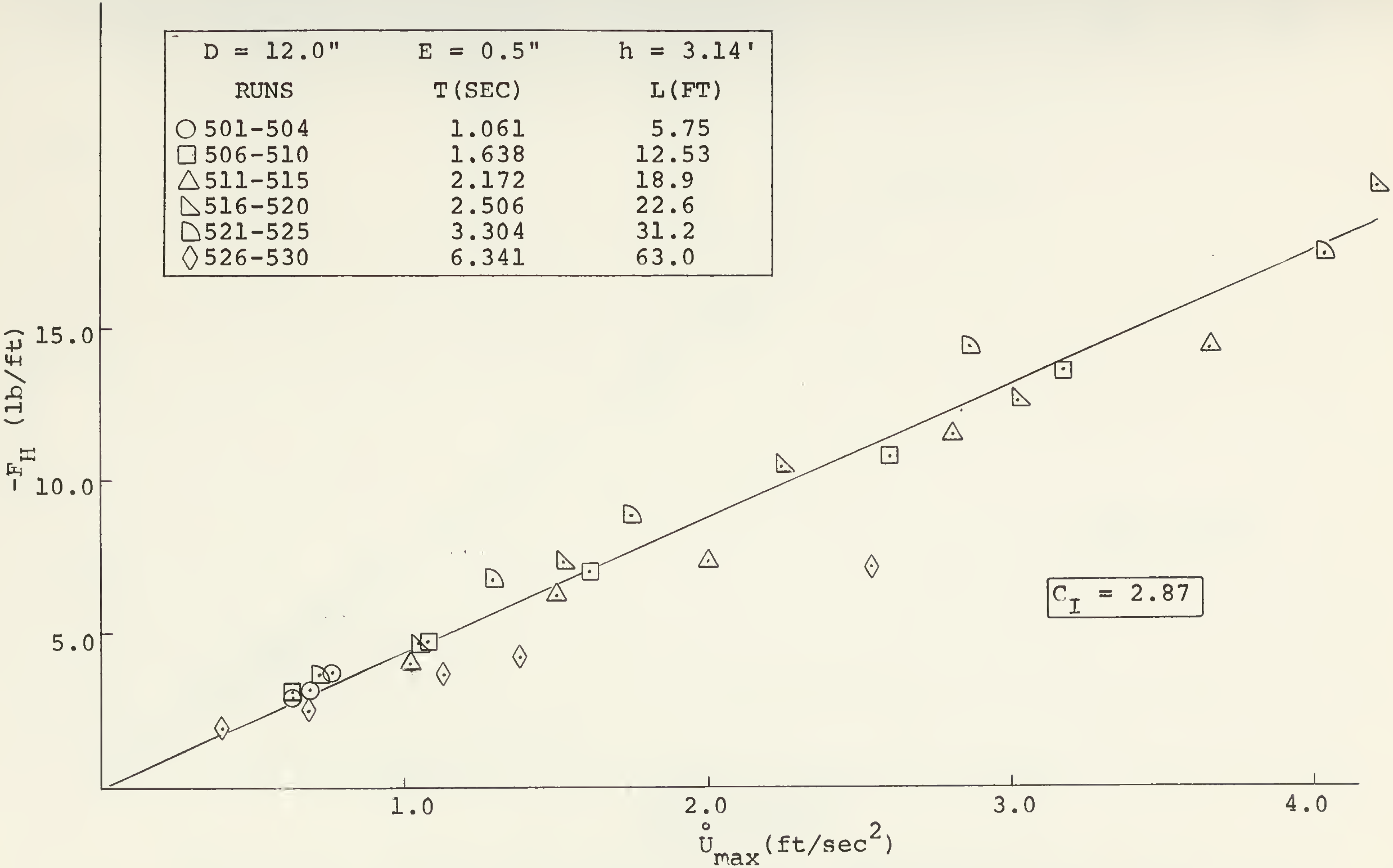

Figure C20. Negative horizontal force vs maximum horizontal acceleration.

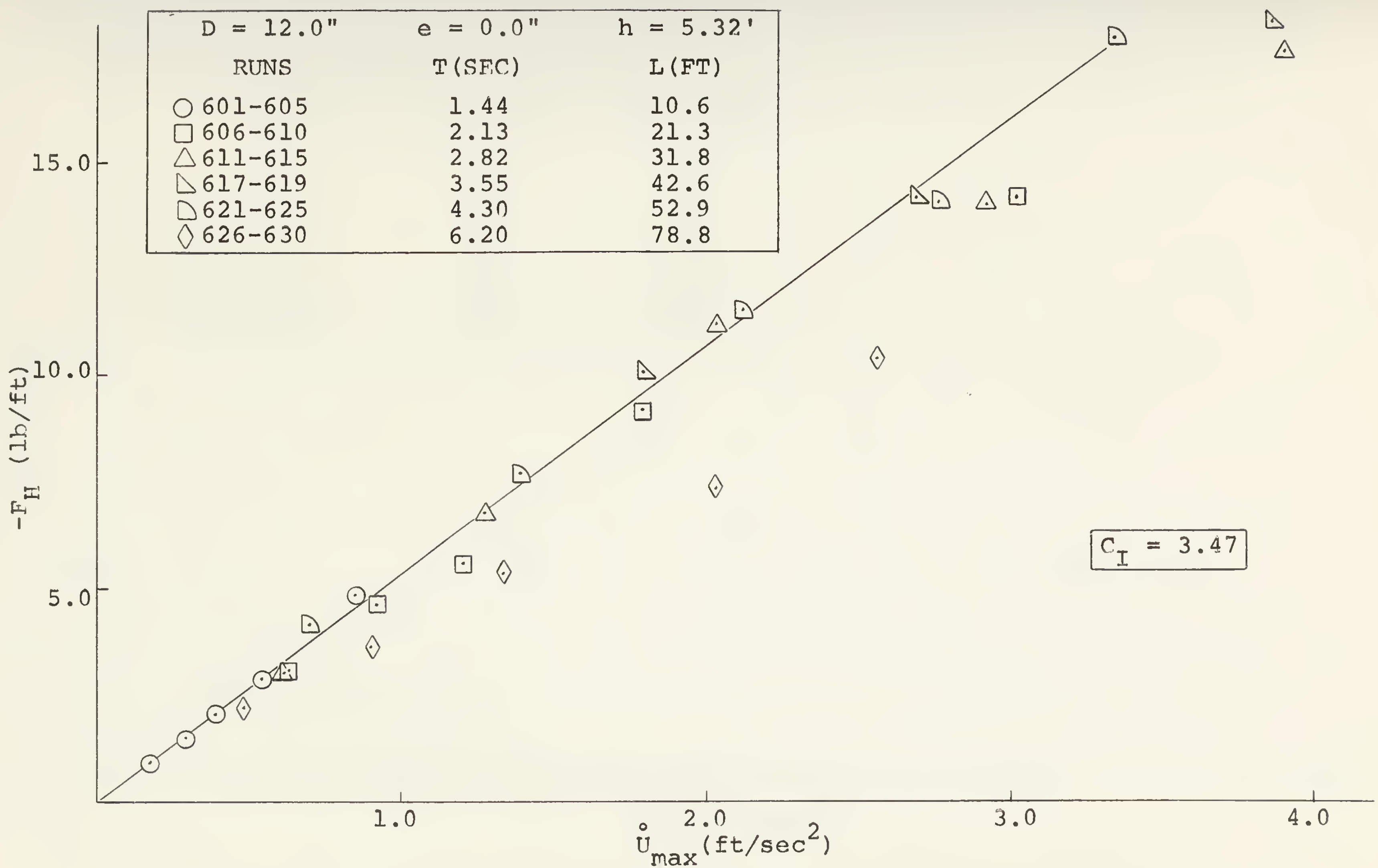

Figure C21. Negative horizontal force vs maximum horizontal acceleration.

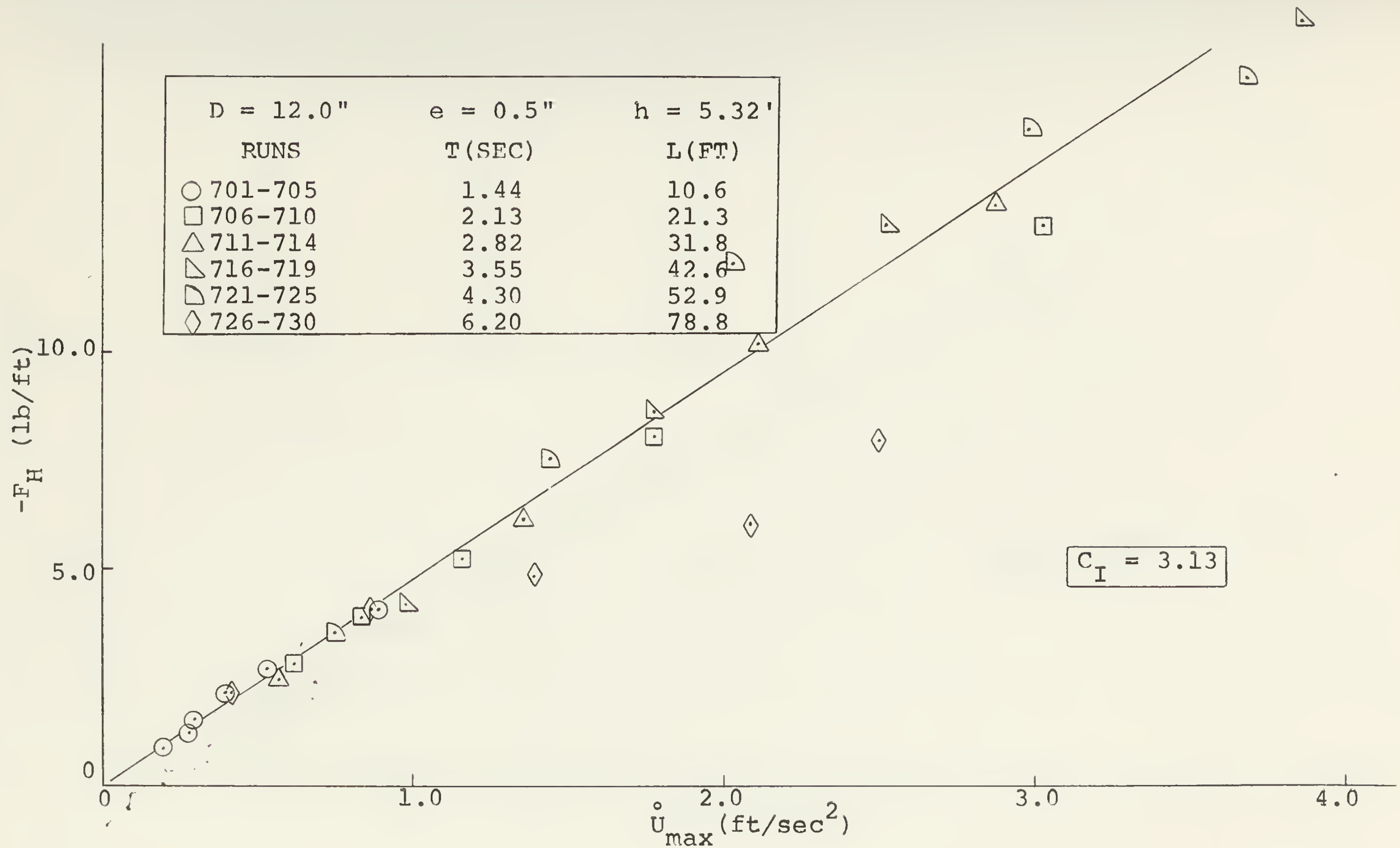

Figure C22. Negative horizontal force vs maximum horizontal acceleration.

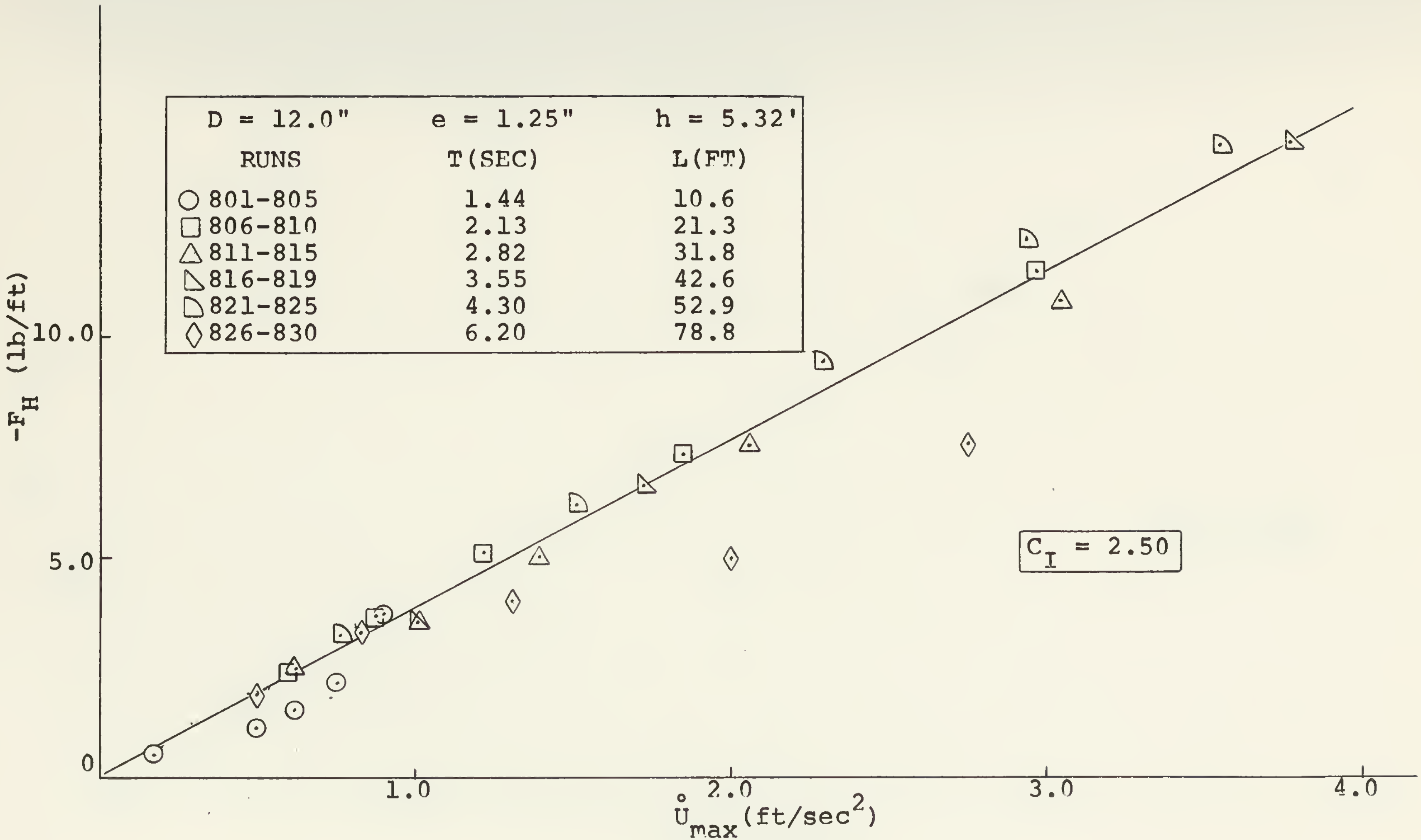

Figure C23. Negative horizontal force vs maximum horizontal acceleration.

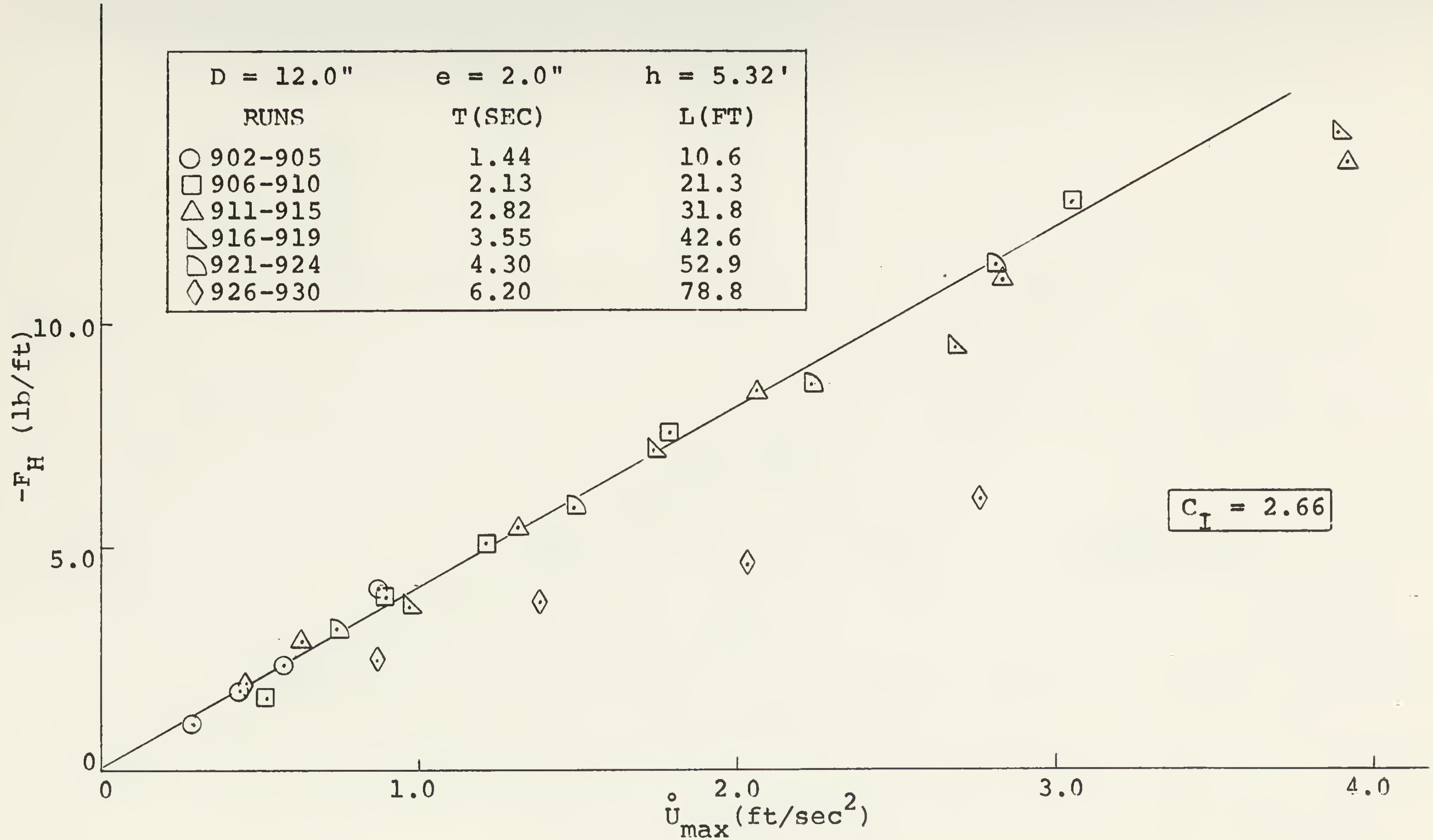

Figure C24. Negative horizontal force vs maximum horizontal acceleration.

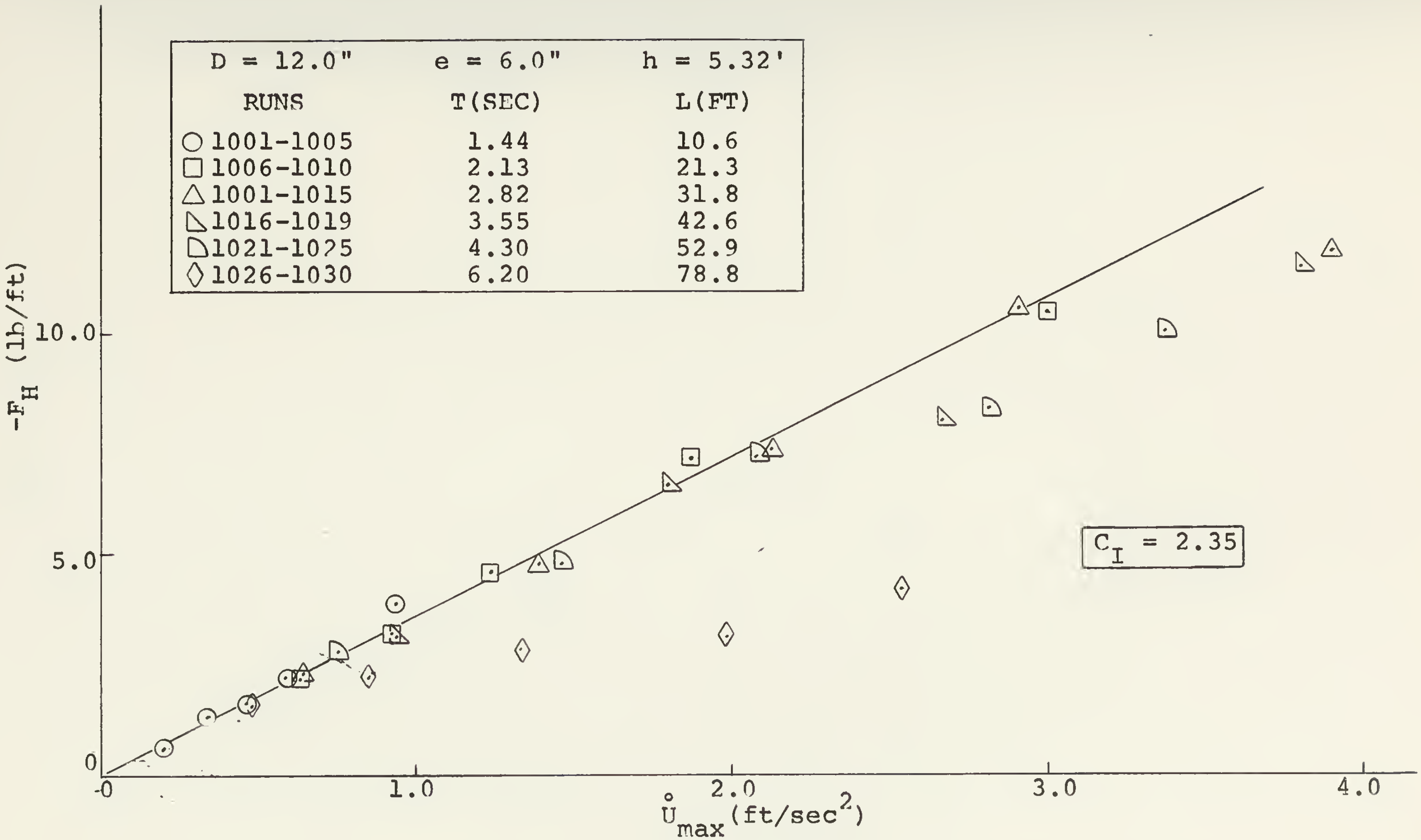

Figure C25. Negative horizontal force vs maximum horizontal acceleration.

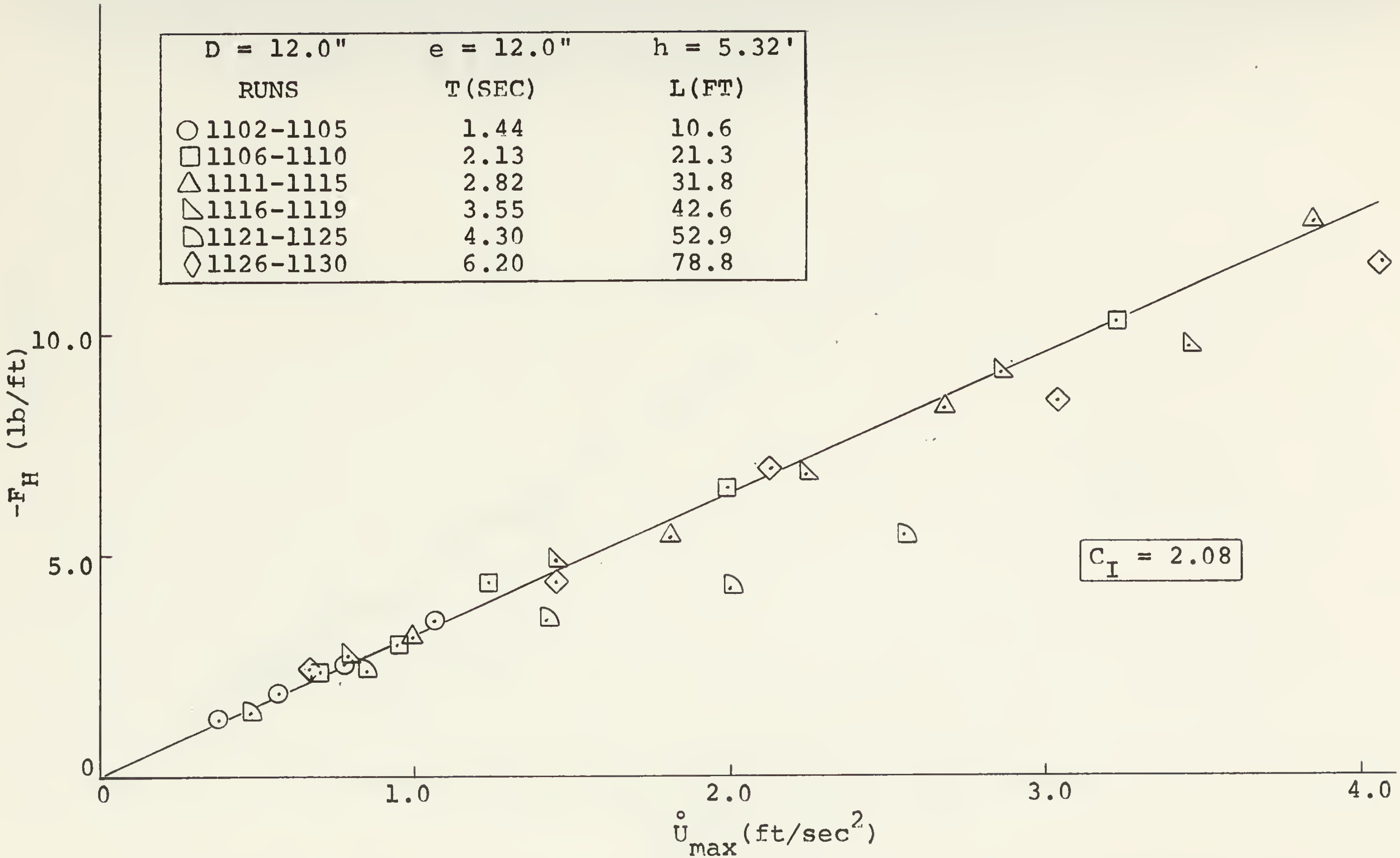

Figure C26. Negative horizontal force vs maximum horizontal acceleration.

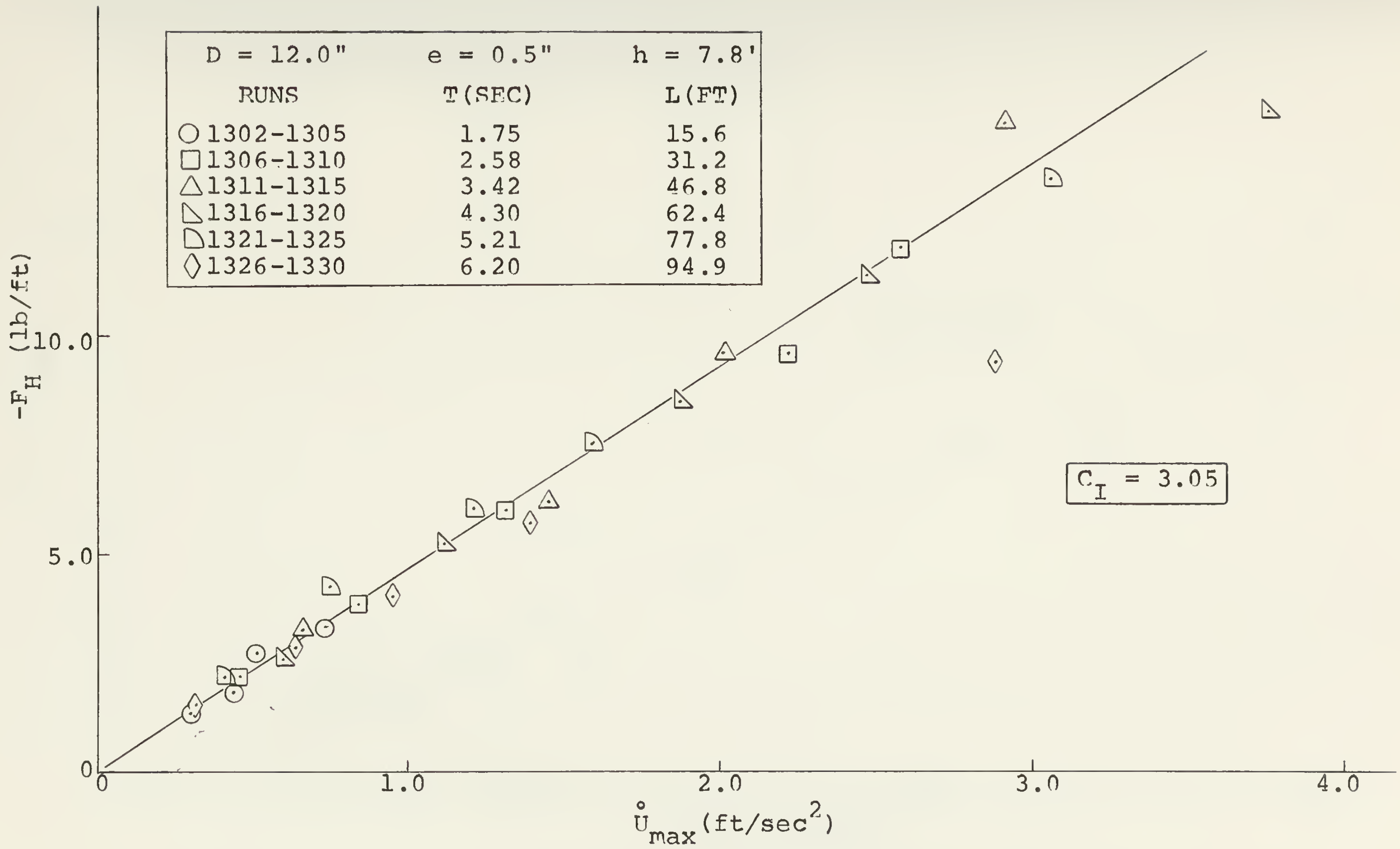

Figure C27. Negative horizontal force vs maximum horizontal acceleration.

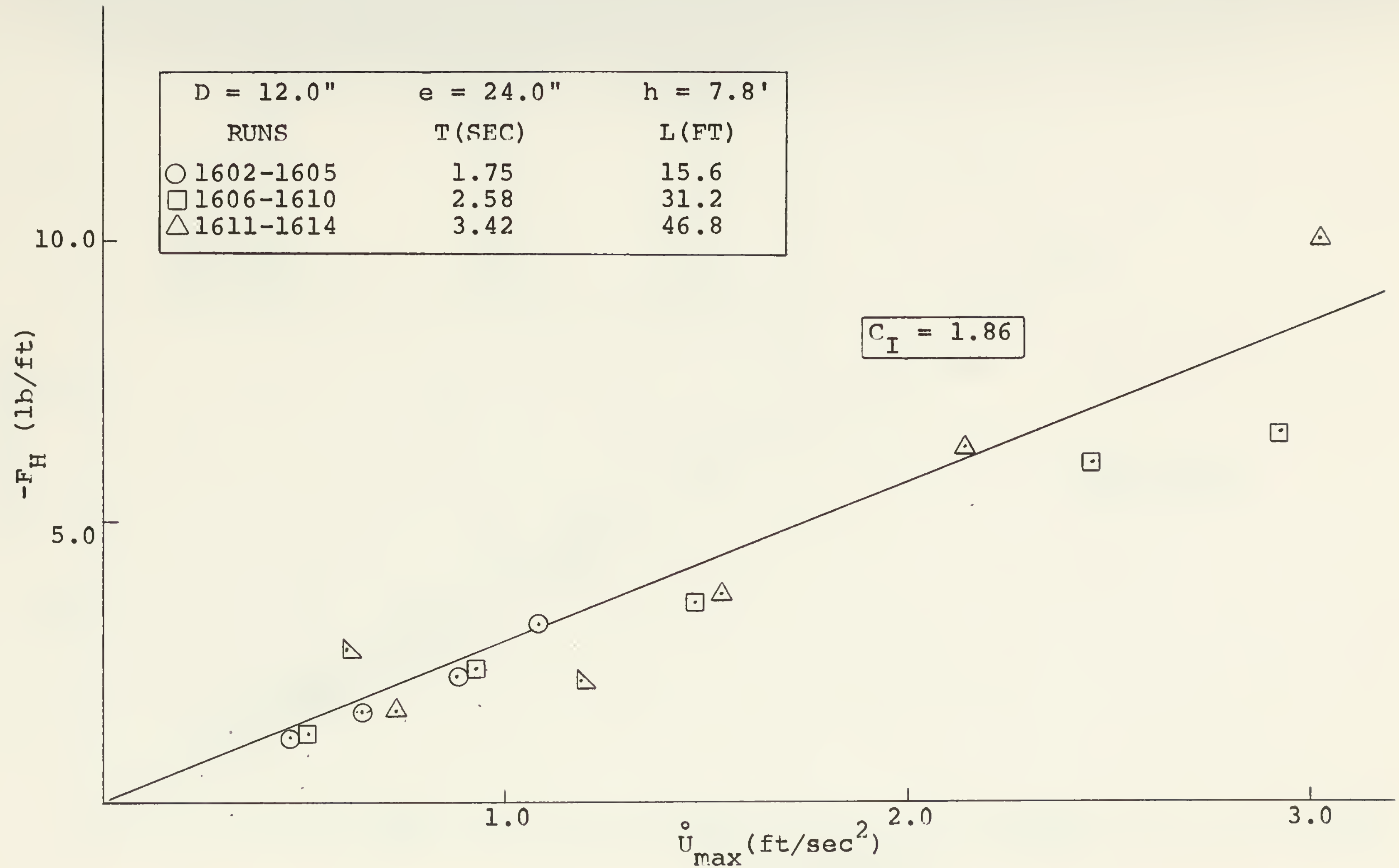

Figure C28. Negative horizontal force vs maximum horizontal acceleration.

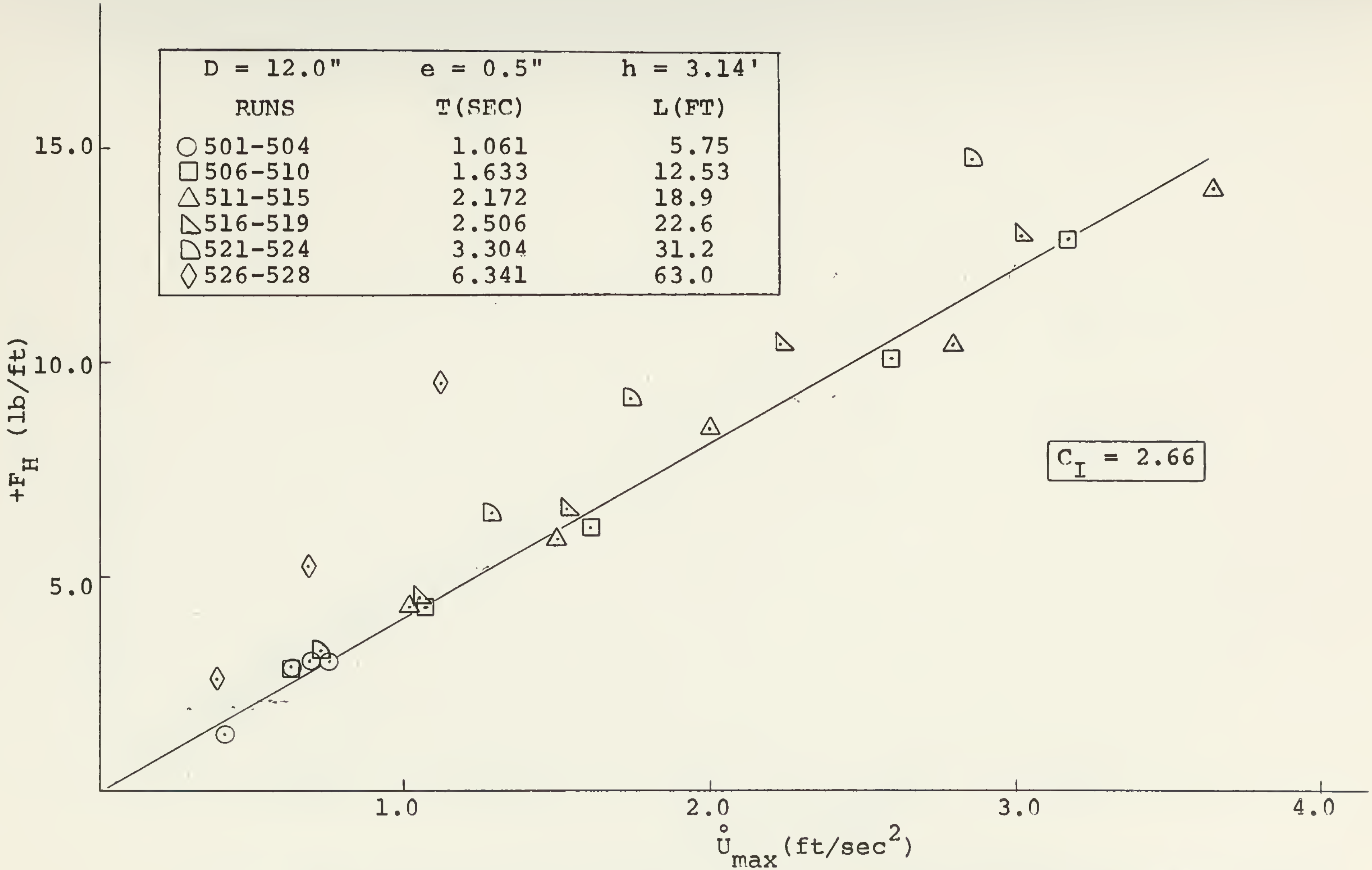

Figure C29. Positive horizontal force vs maximum horizontal acceleration.

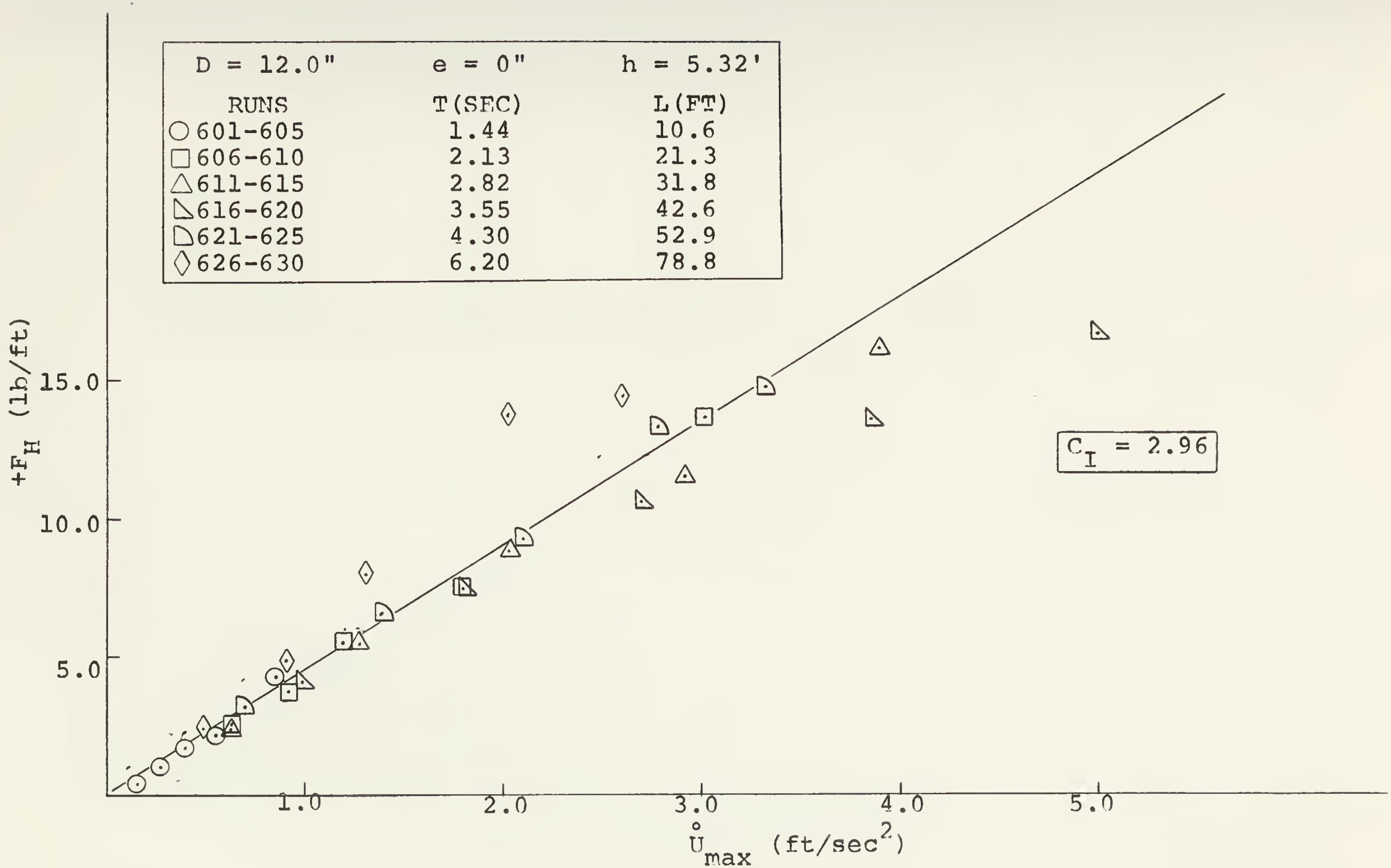

Figure C30. Positive horizontal force vs maximum horizontal acceleration.

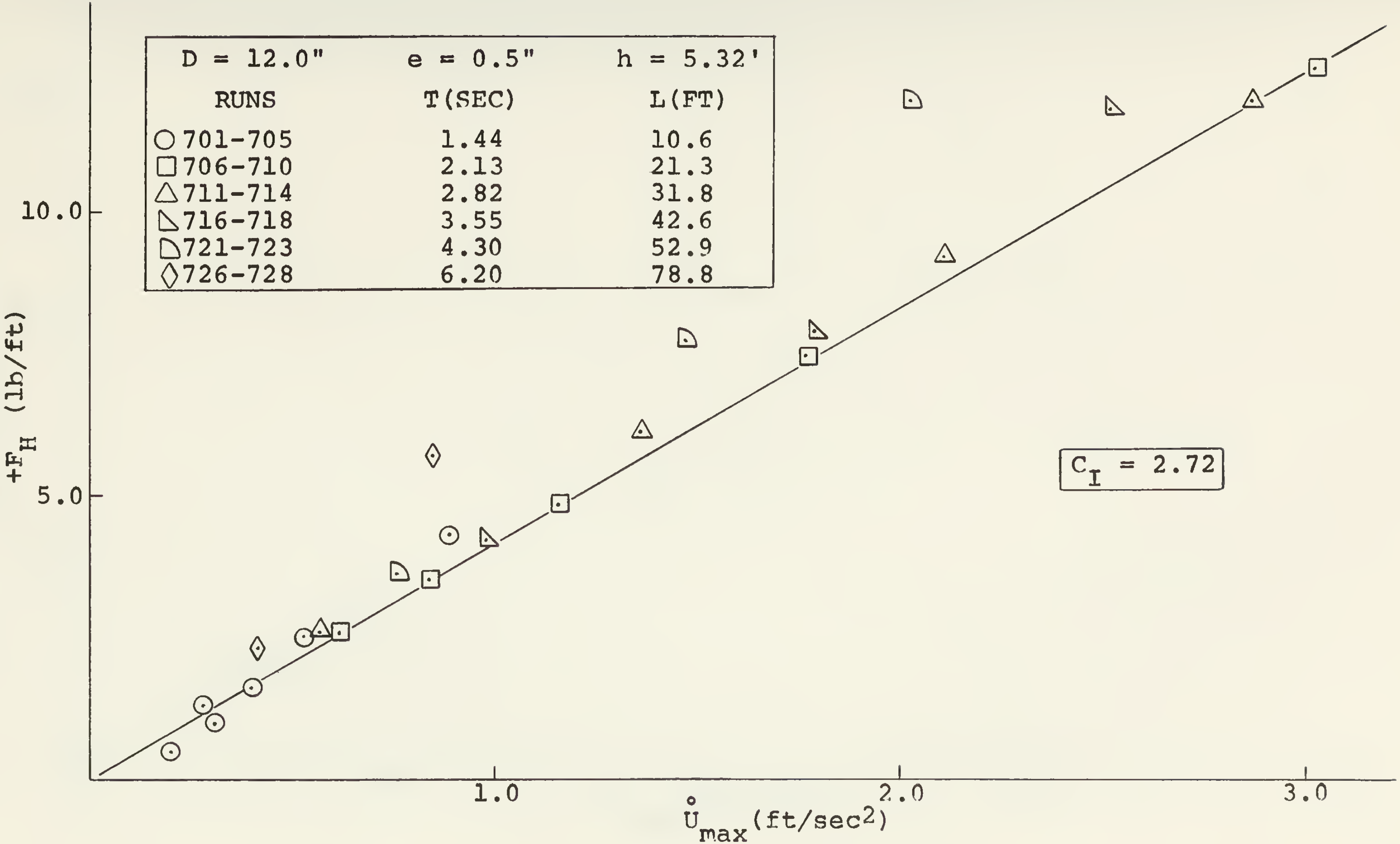

Figure C31. Positive horizontal force vs maximum horizontal acceleration.

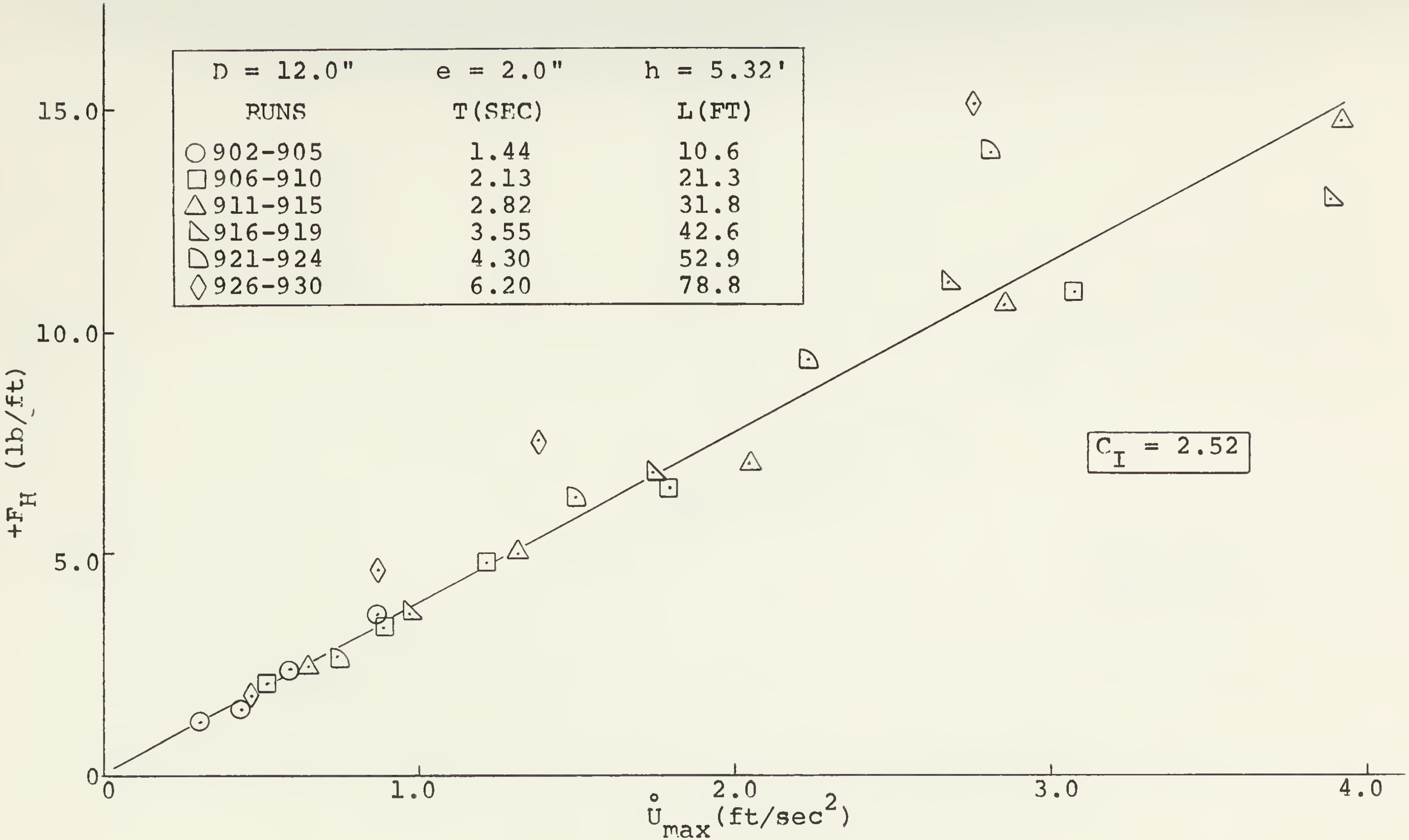

Figure C32. Positive horizontal force vs maximum horizontal acceleration.

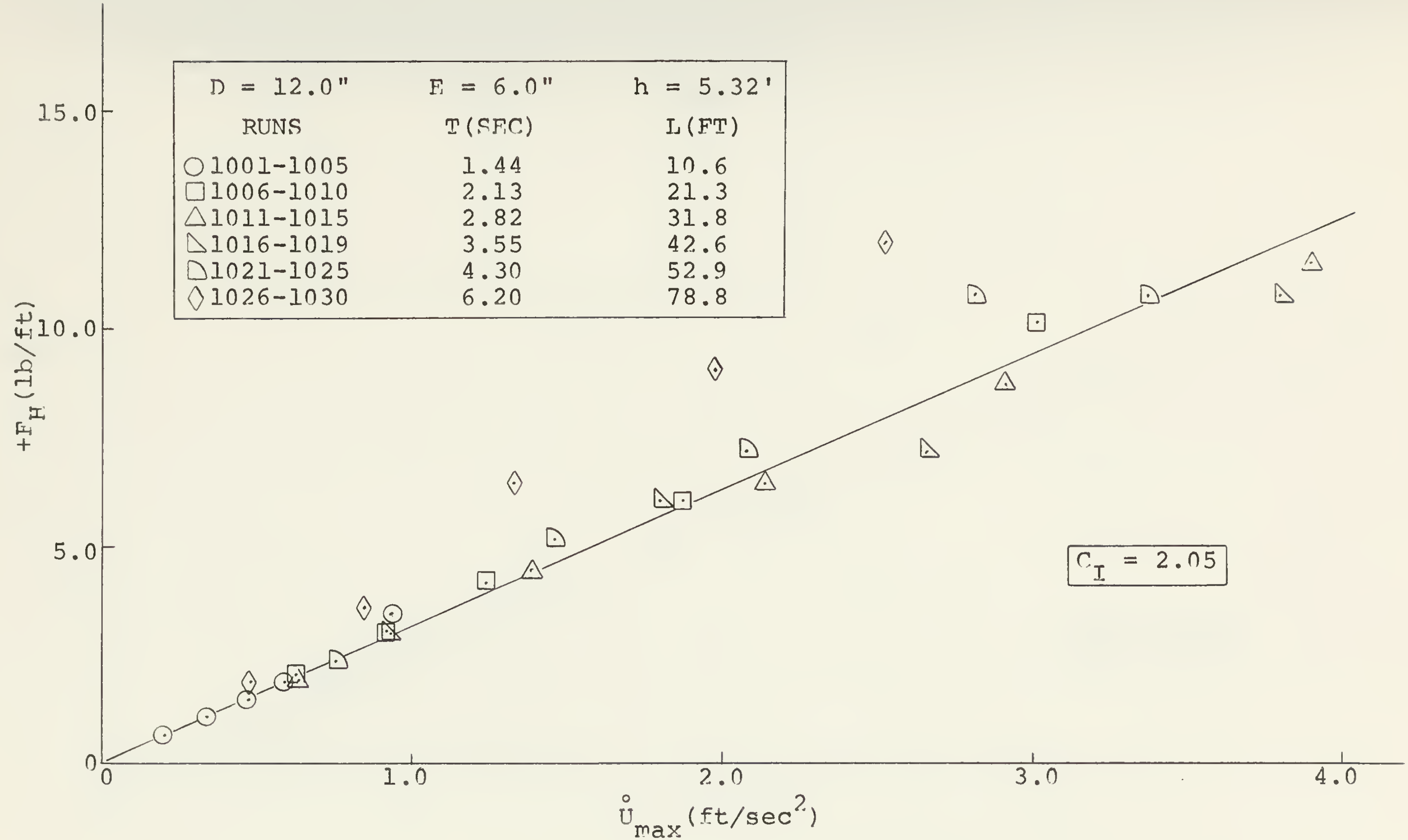

Figure C33. Positive horizontal force vs maximum horizontal acceleration.

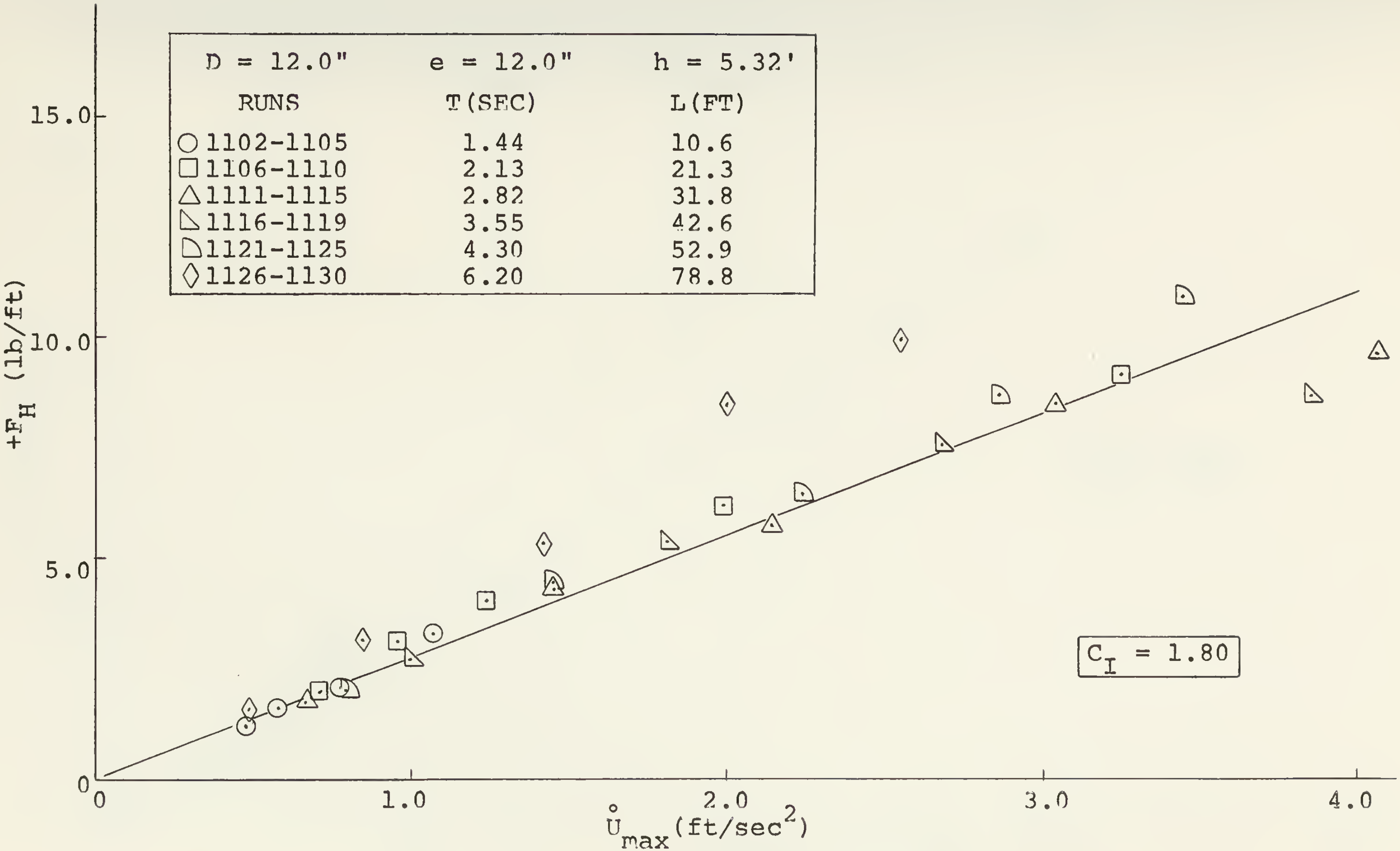

Figure C34. Positive horizontal force vs maximum horizontal acceleration.

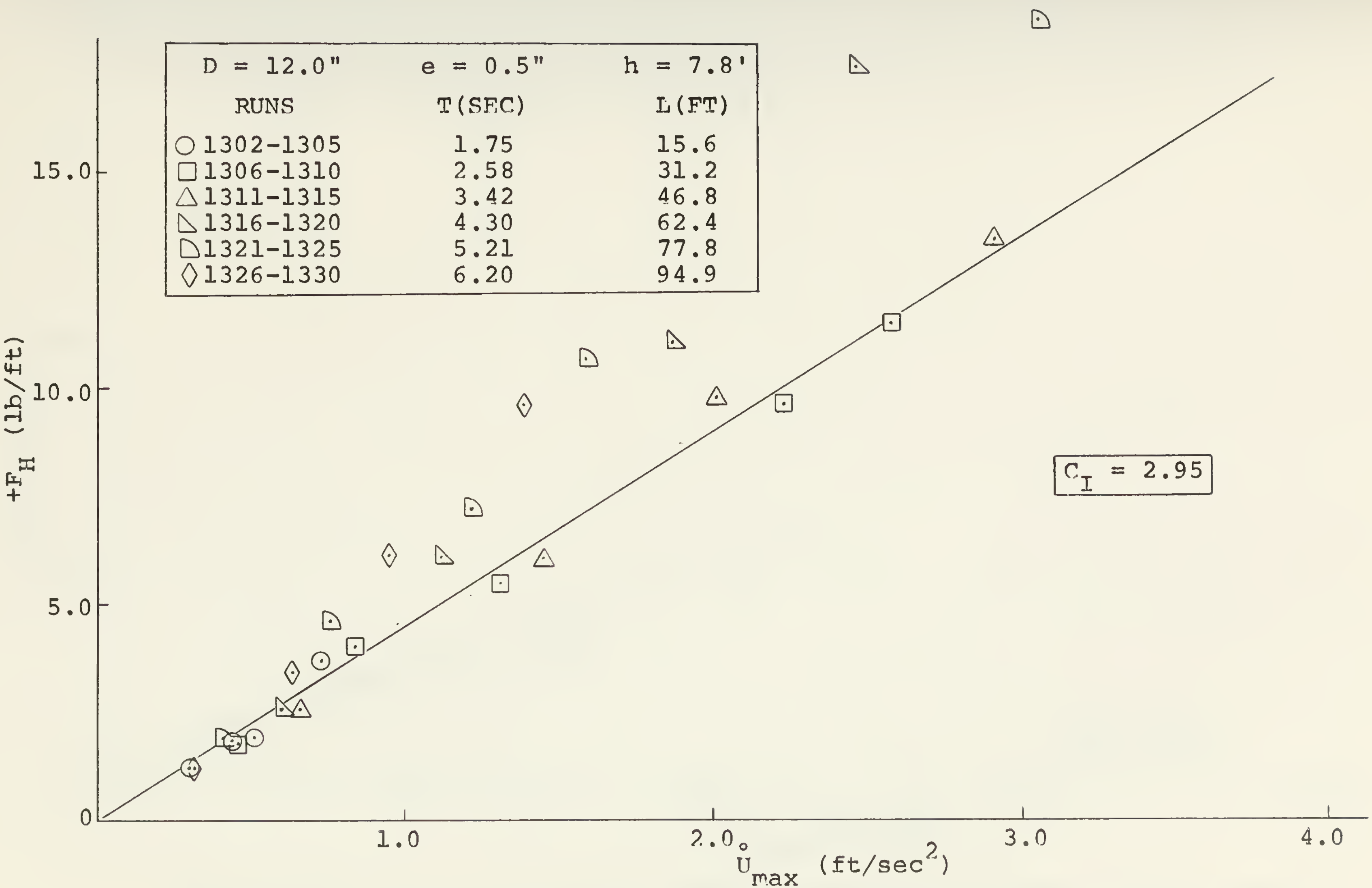

Figure C35. Positive horizontal force vs maximum horizontal acceleration.

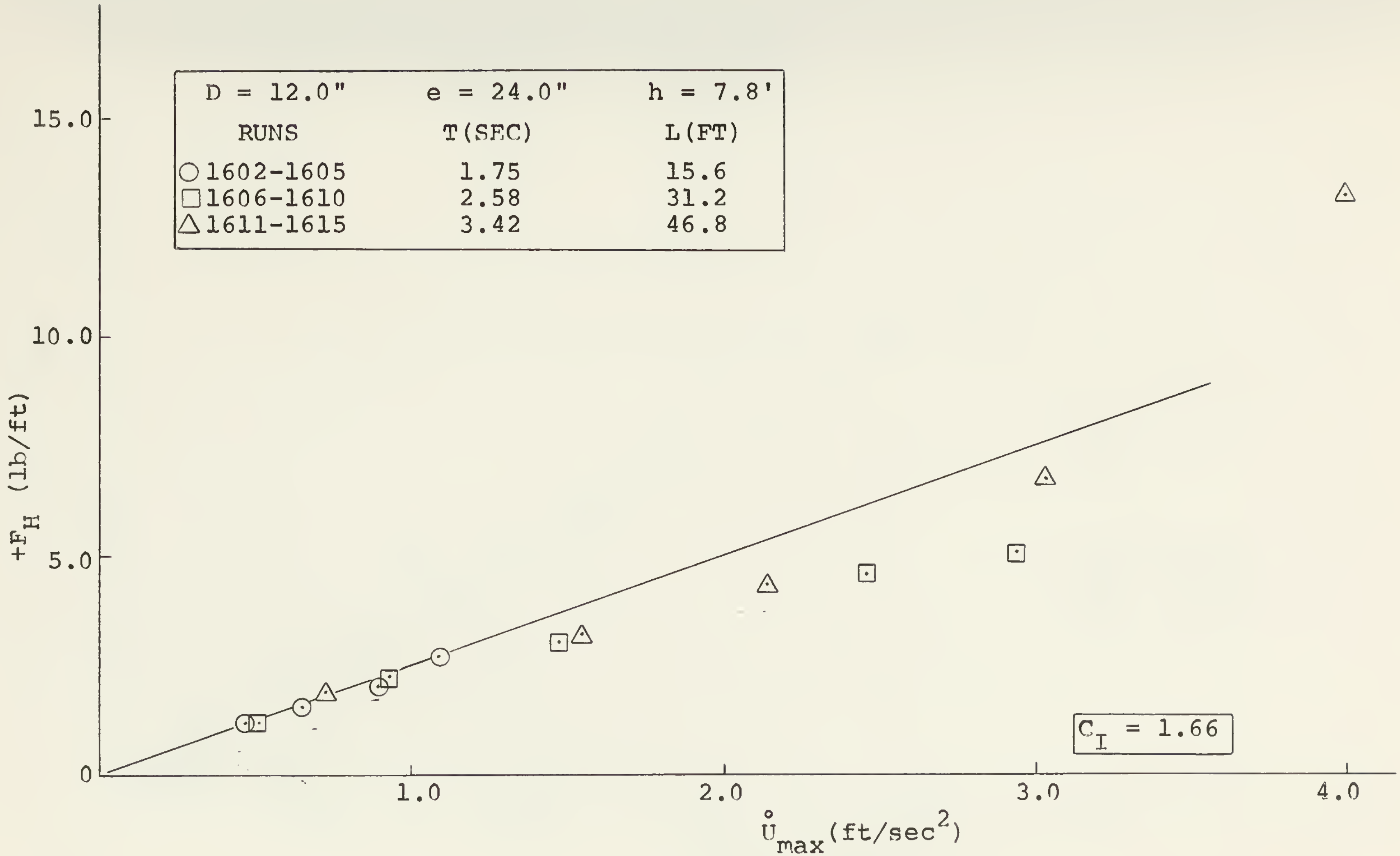

Figure C36. Positive horizontal force vs maximum horizontal acceleration.

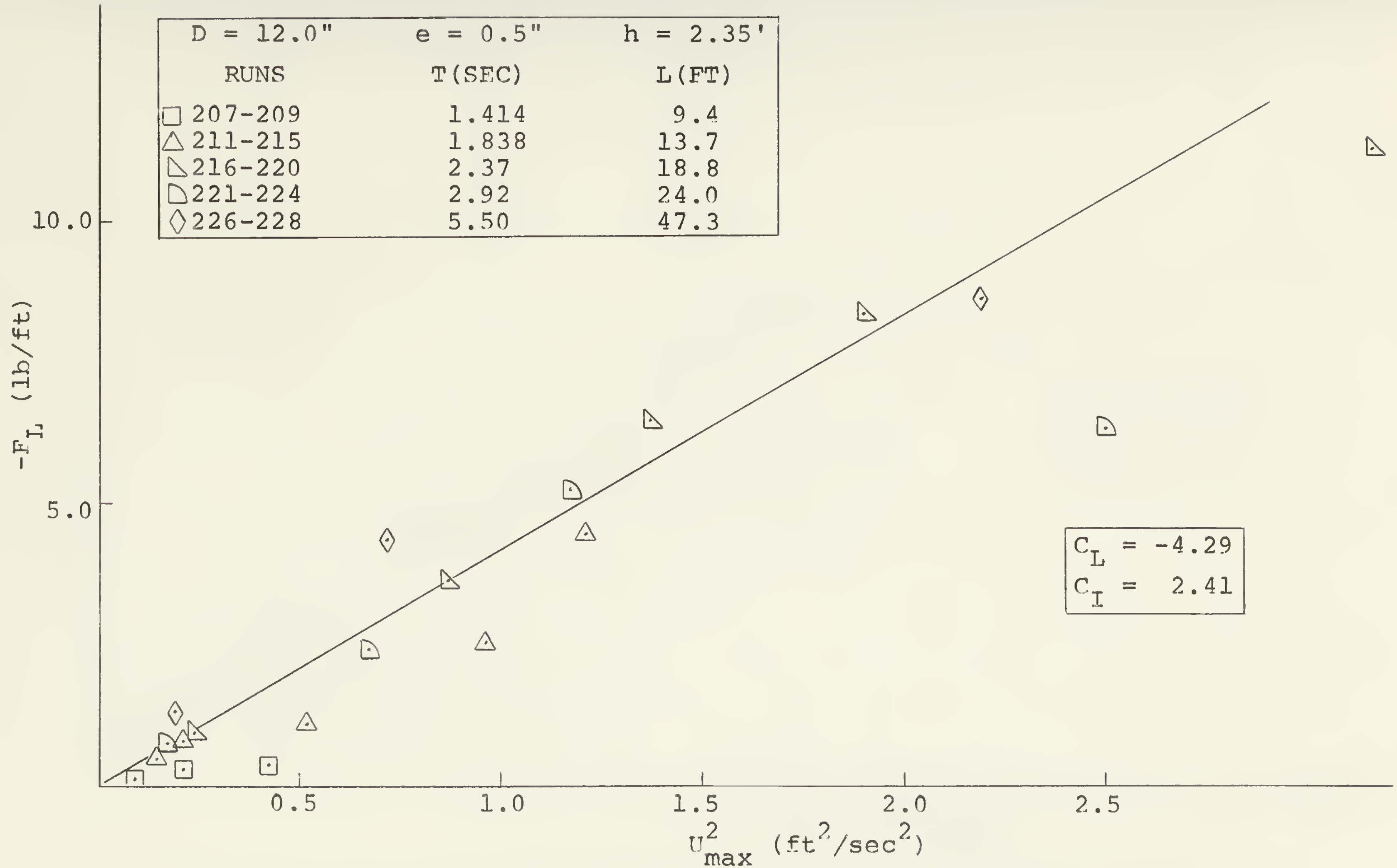

Figure C37. Negative lift force vs maximum horizontal velocity squared.

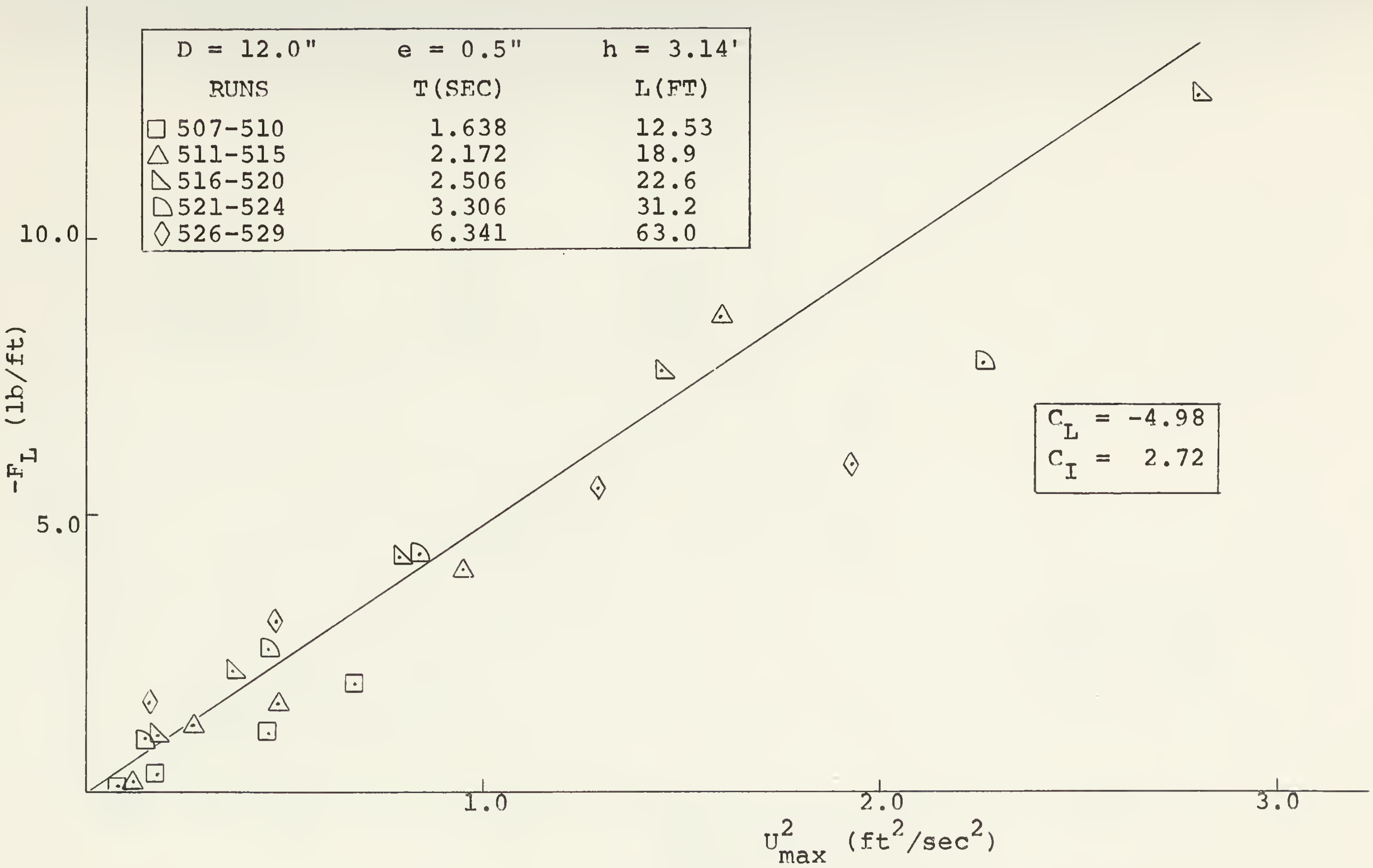

Figure C38. Negative lift force vs maximum horizontal velocity squared.

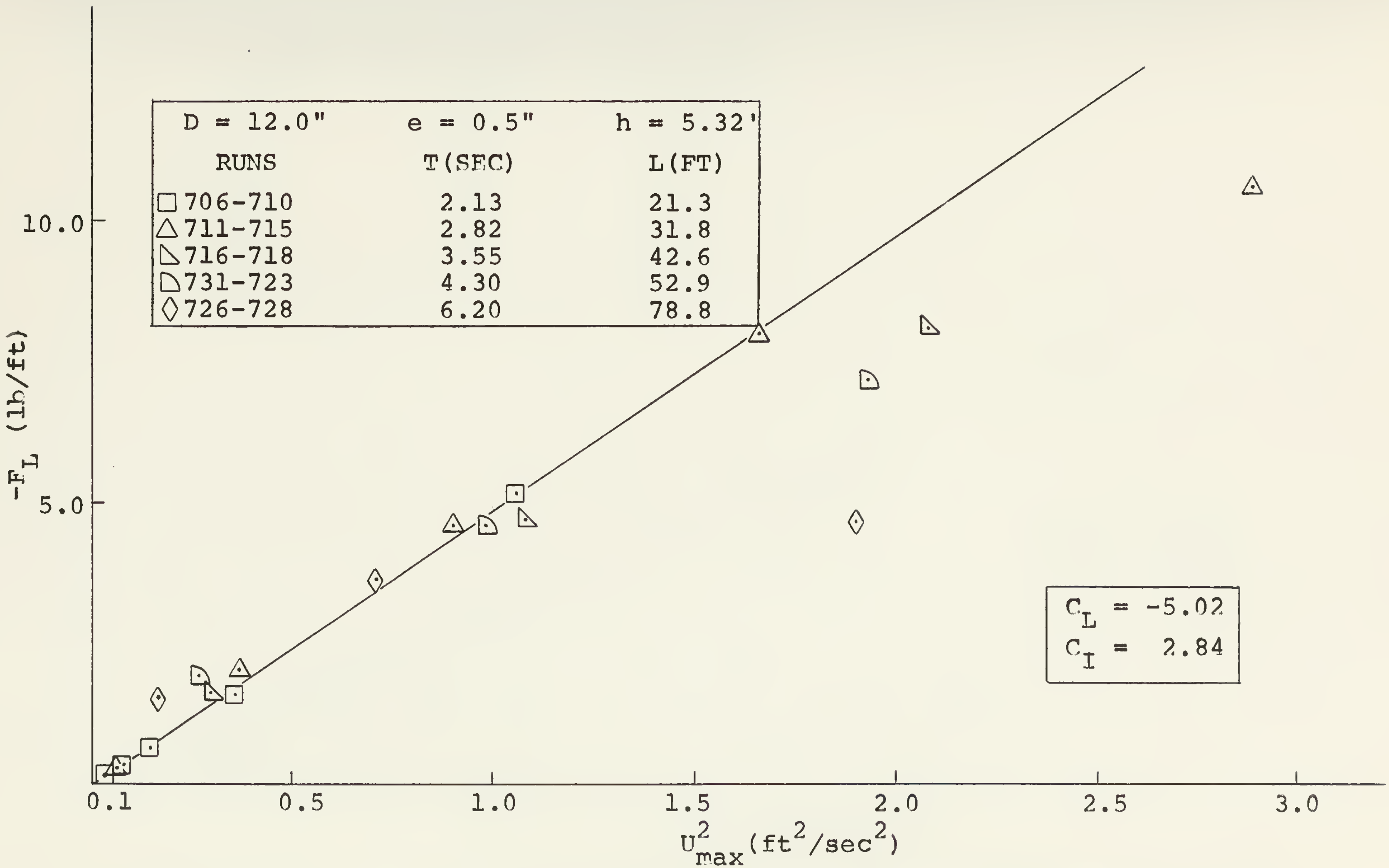

Figure C39. Negative lift force vs maximum horizontal velocity squared.

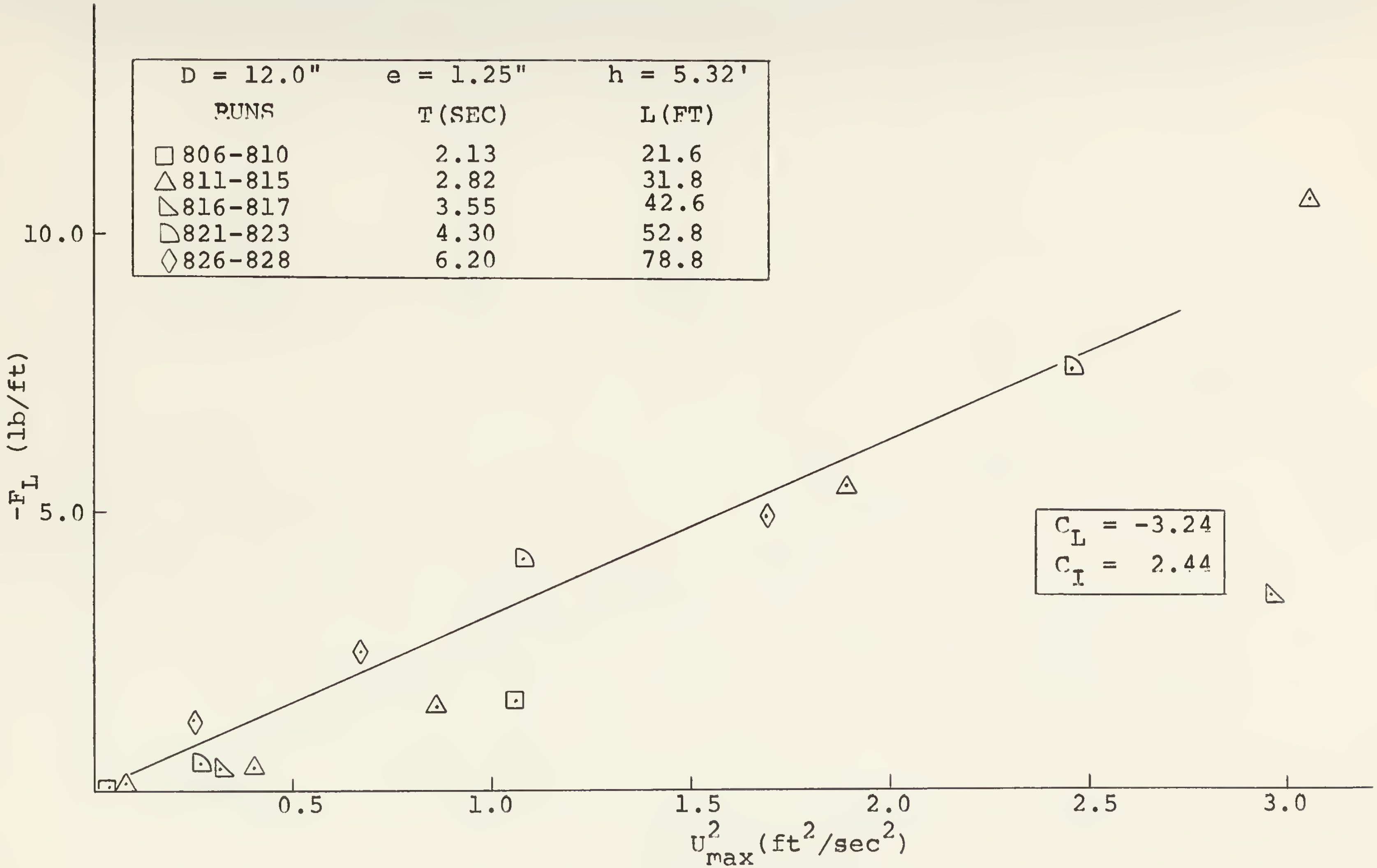

Figure C40. Negative lift force vs maximum horizontal velocity squared.

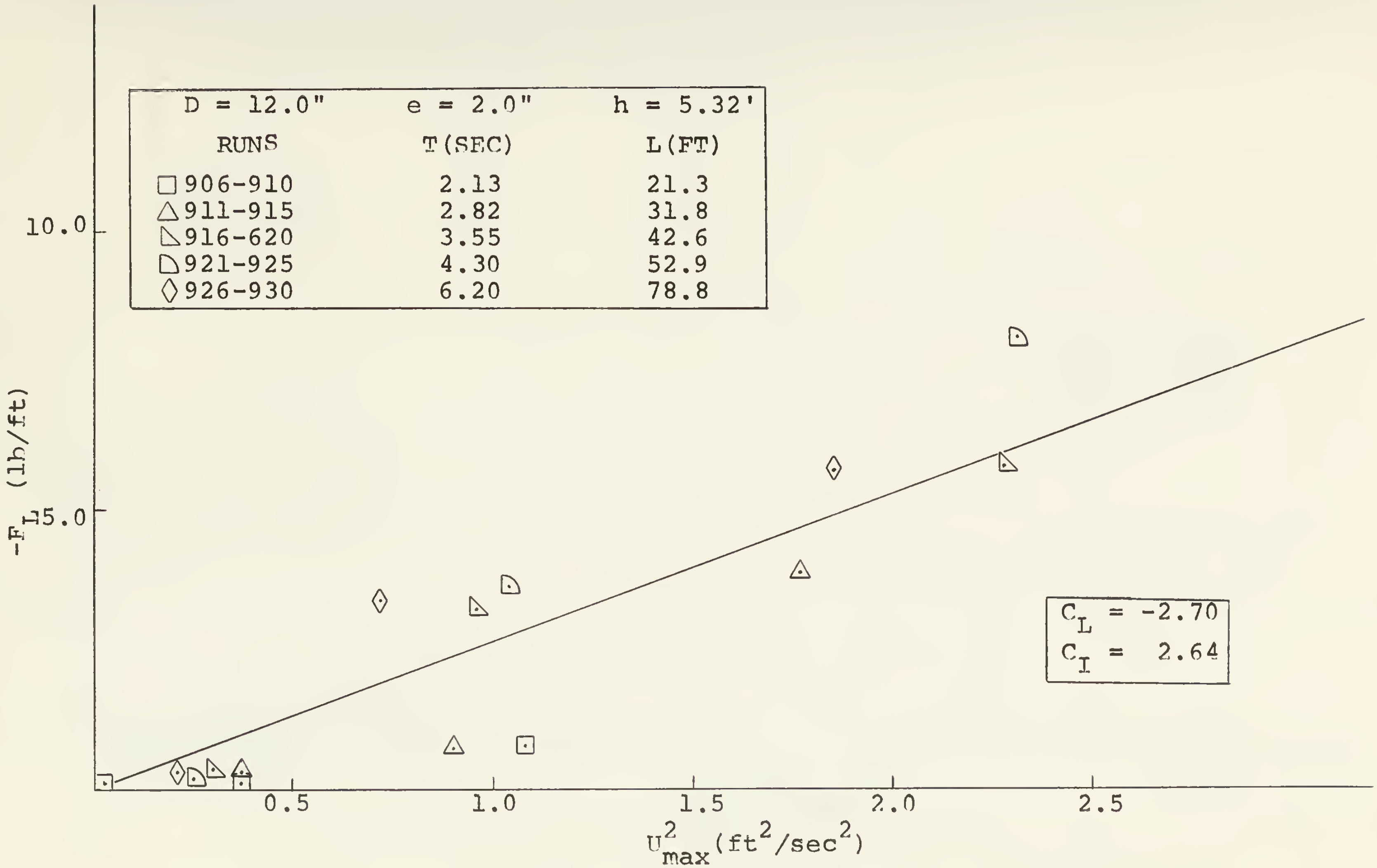

Figure C41. Negative lift force vs maximum horizontal velocity squared.

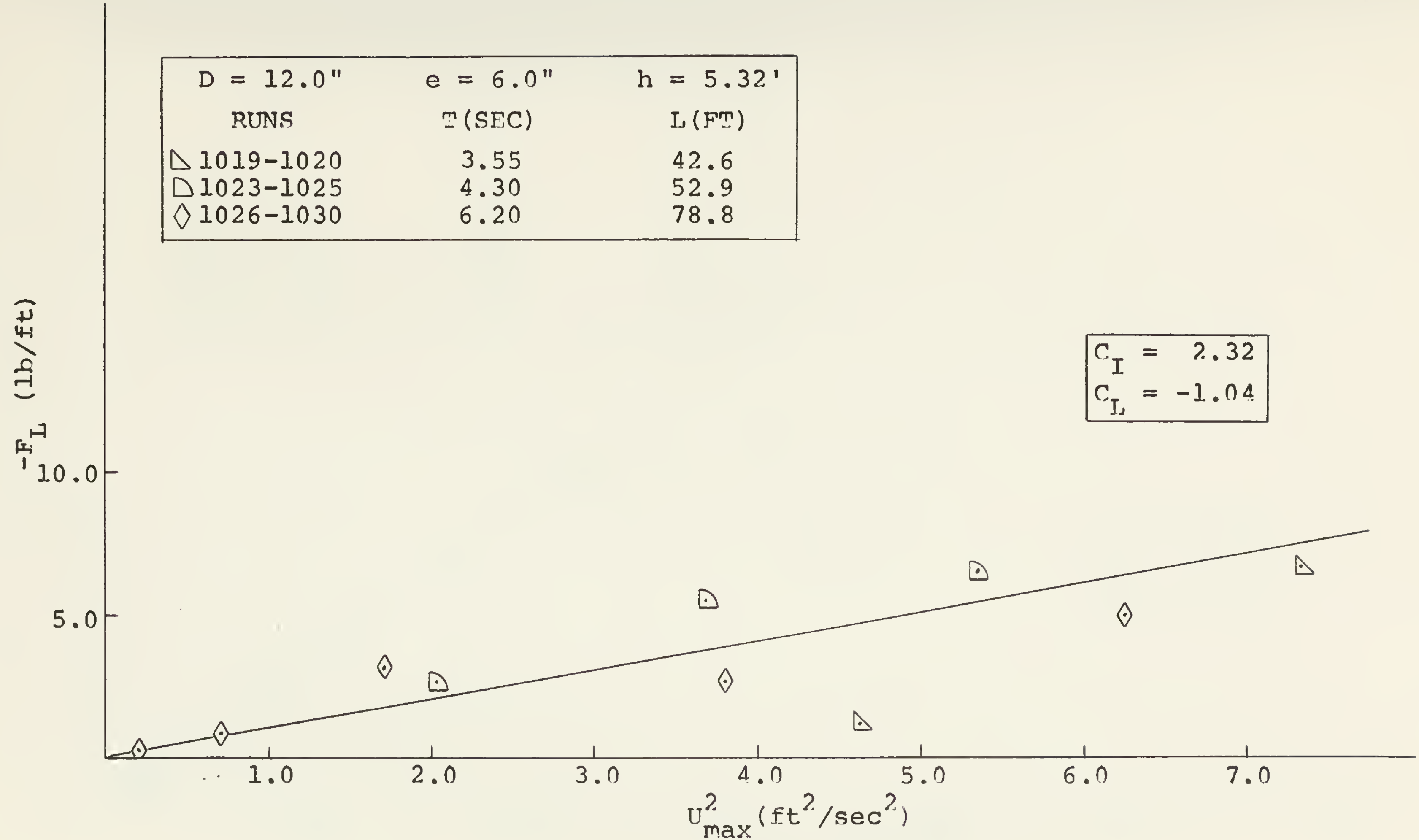

Figure C42. Negative lift force vs maximum horizontal velocity squared.

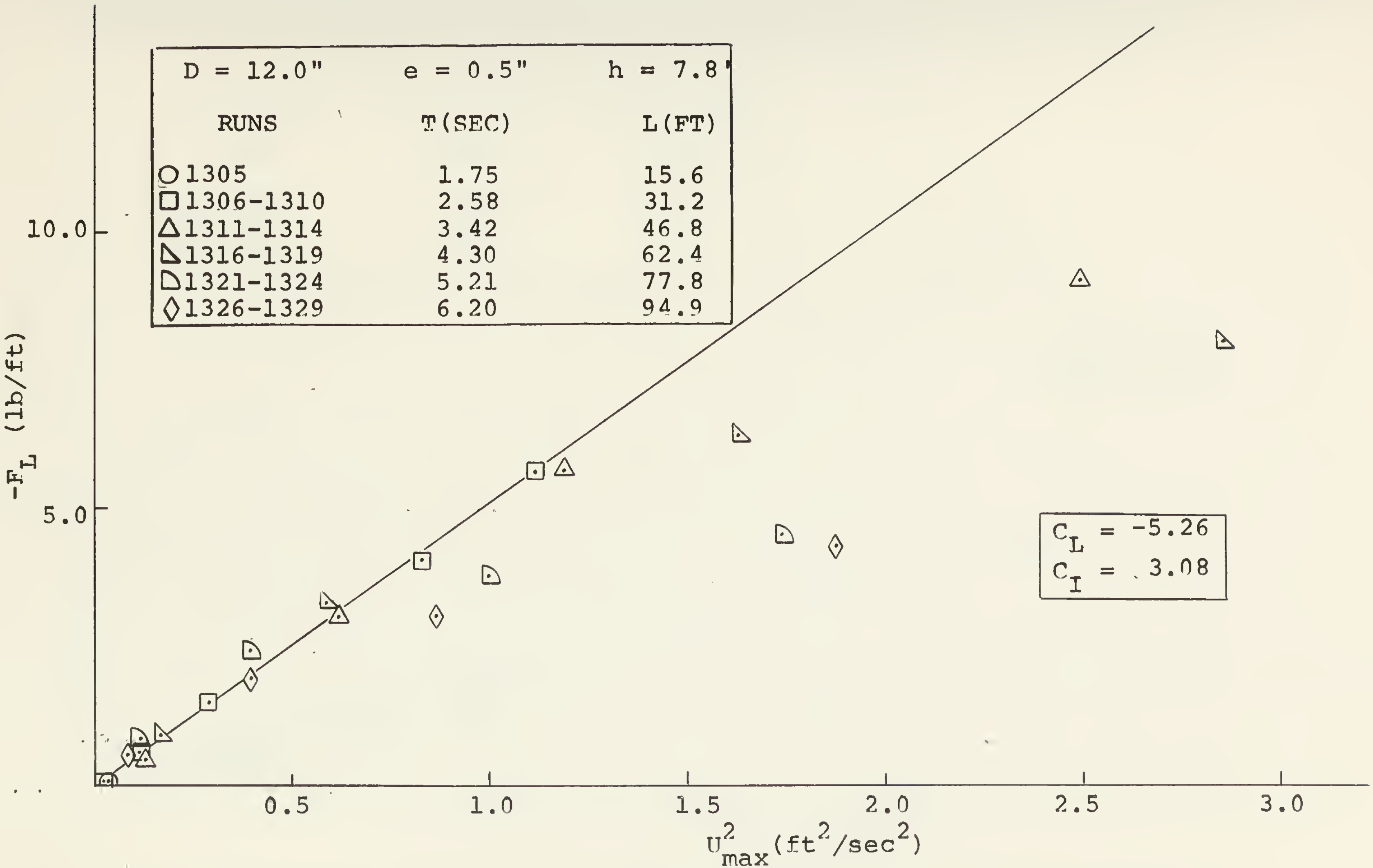

Figure C43. Negative lift force vs maximum horizontal velocity squared.

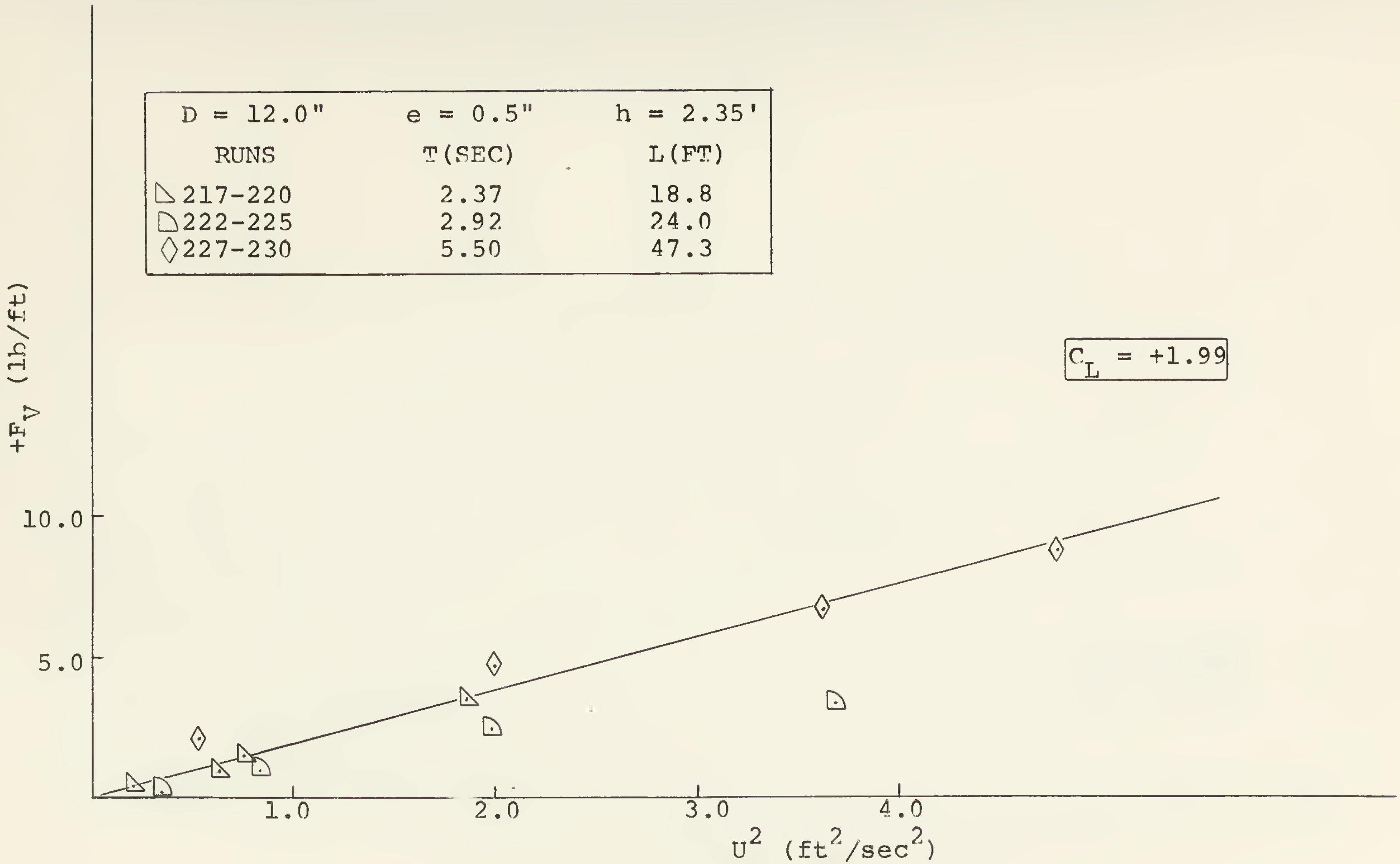

Figure C44. Positive vertical force vs horizontal velocity squared.

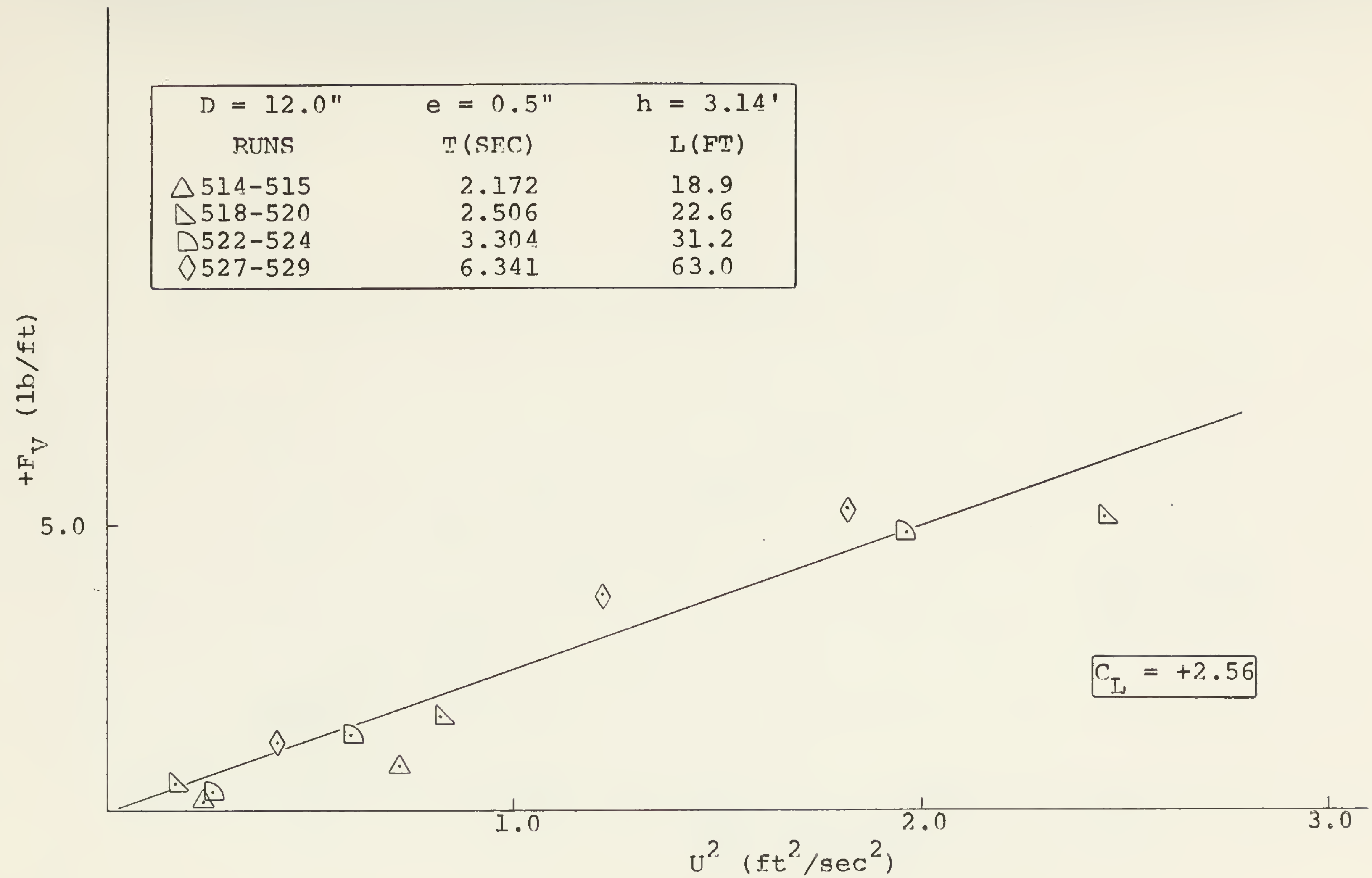

Figure C45. Positive vertical force vs horizontal velocity squared.

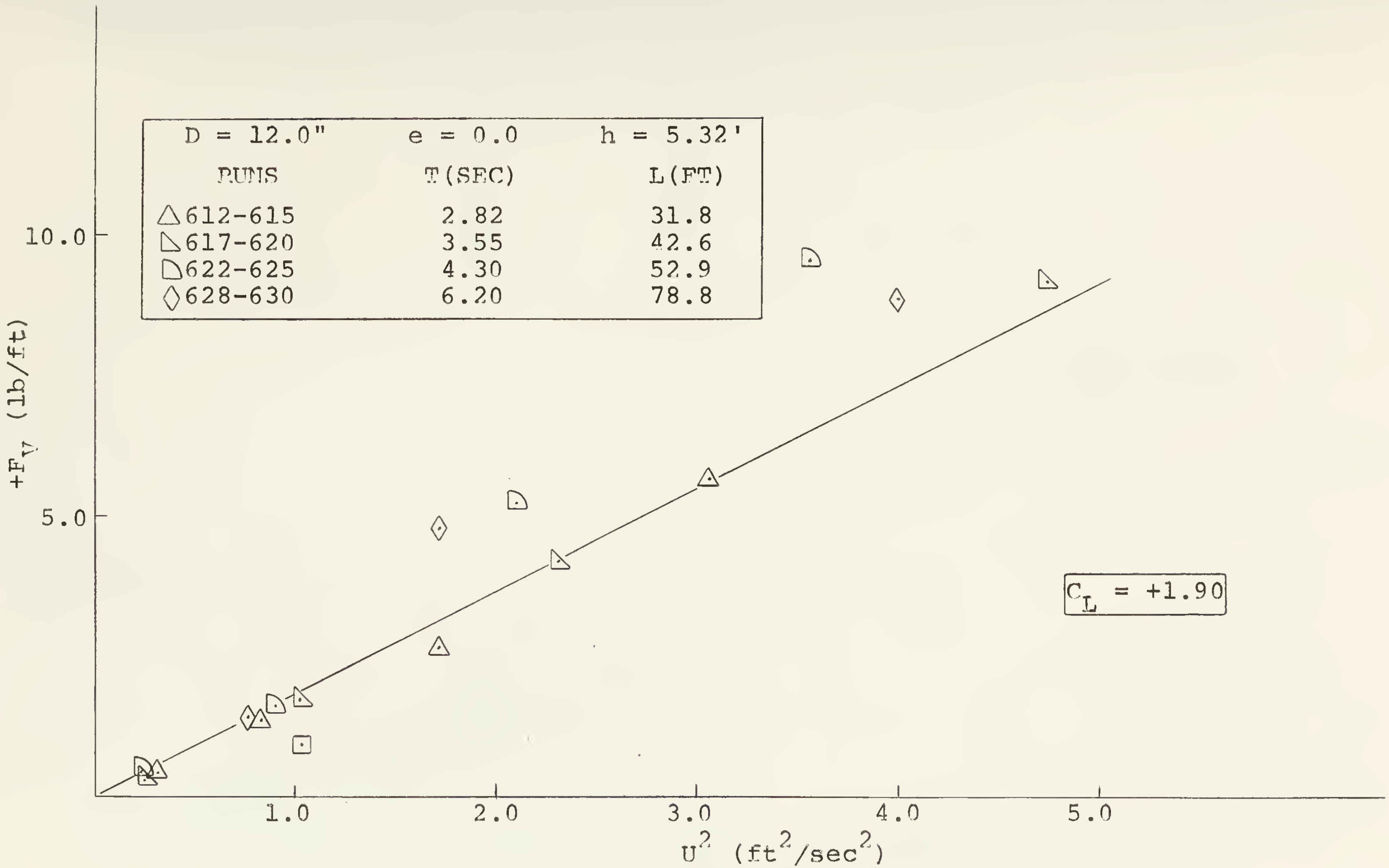

Figure C46. Positive vertical force vs horizontal velocity squared.

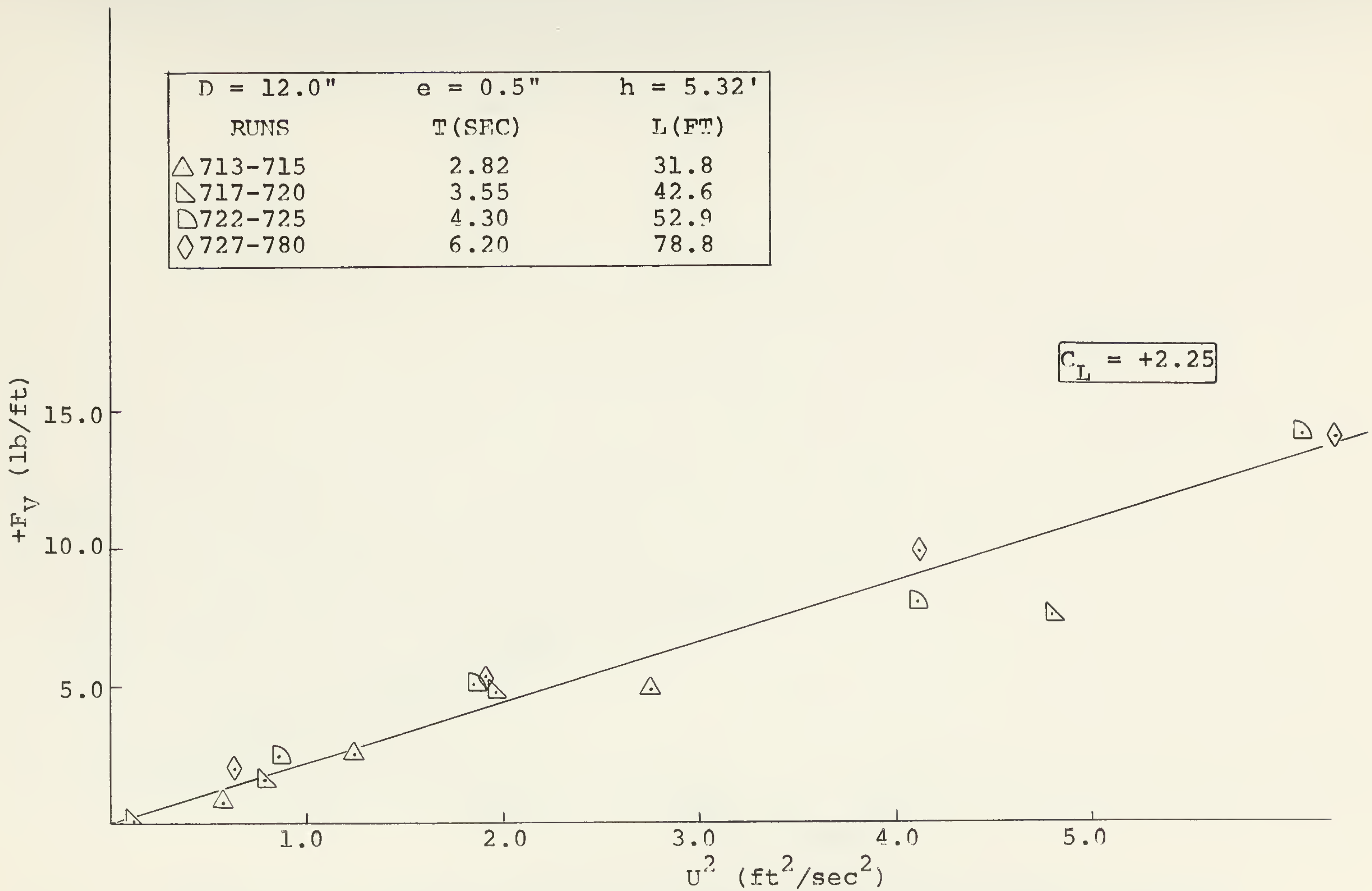

Figure C47. Positive vertical force vs horizontal velocity squared.

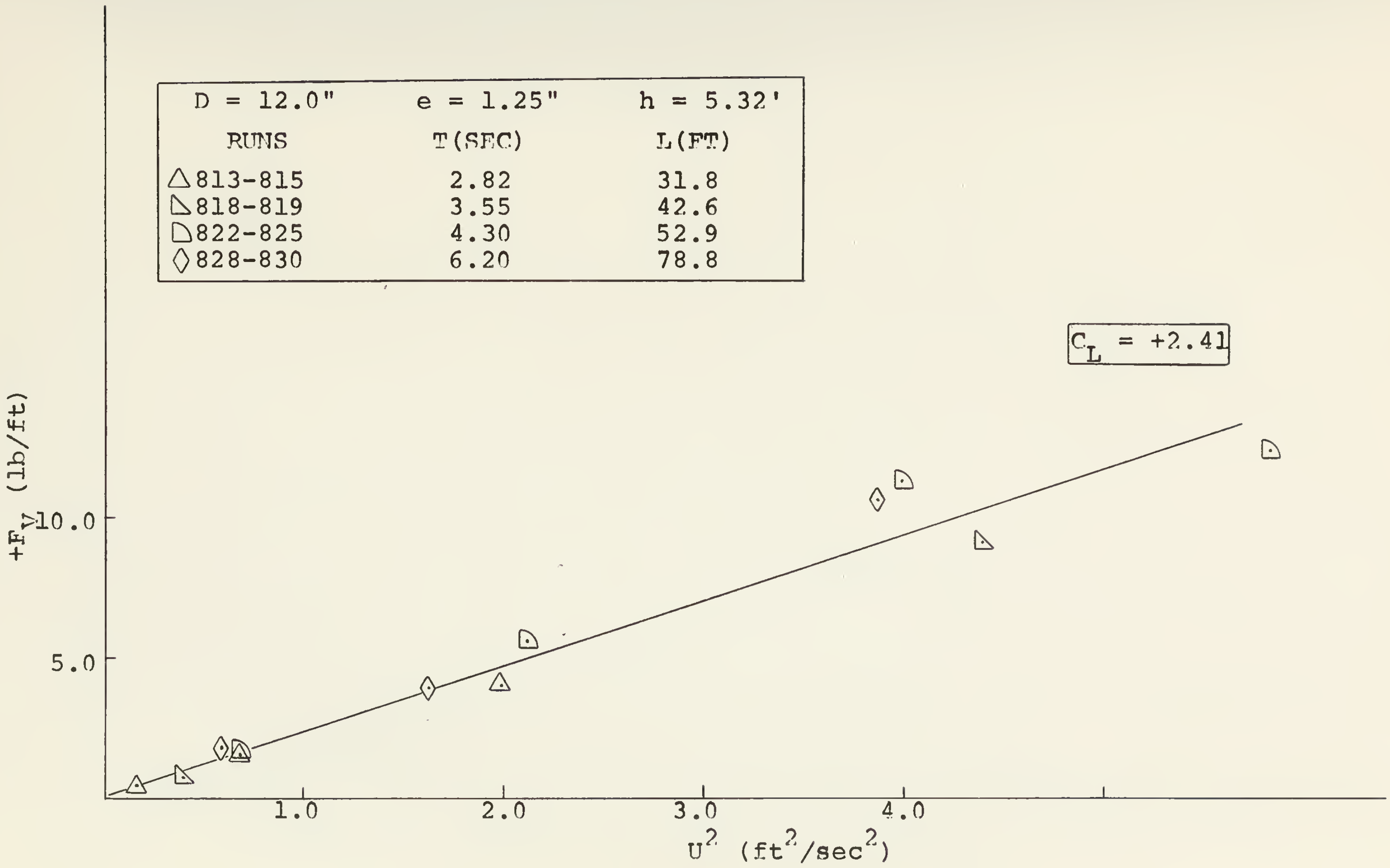

Figure C48. Positive vertical force vs horizontal velocity squared.

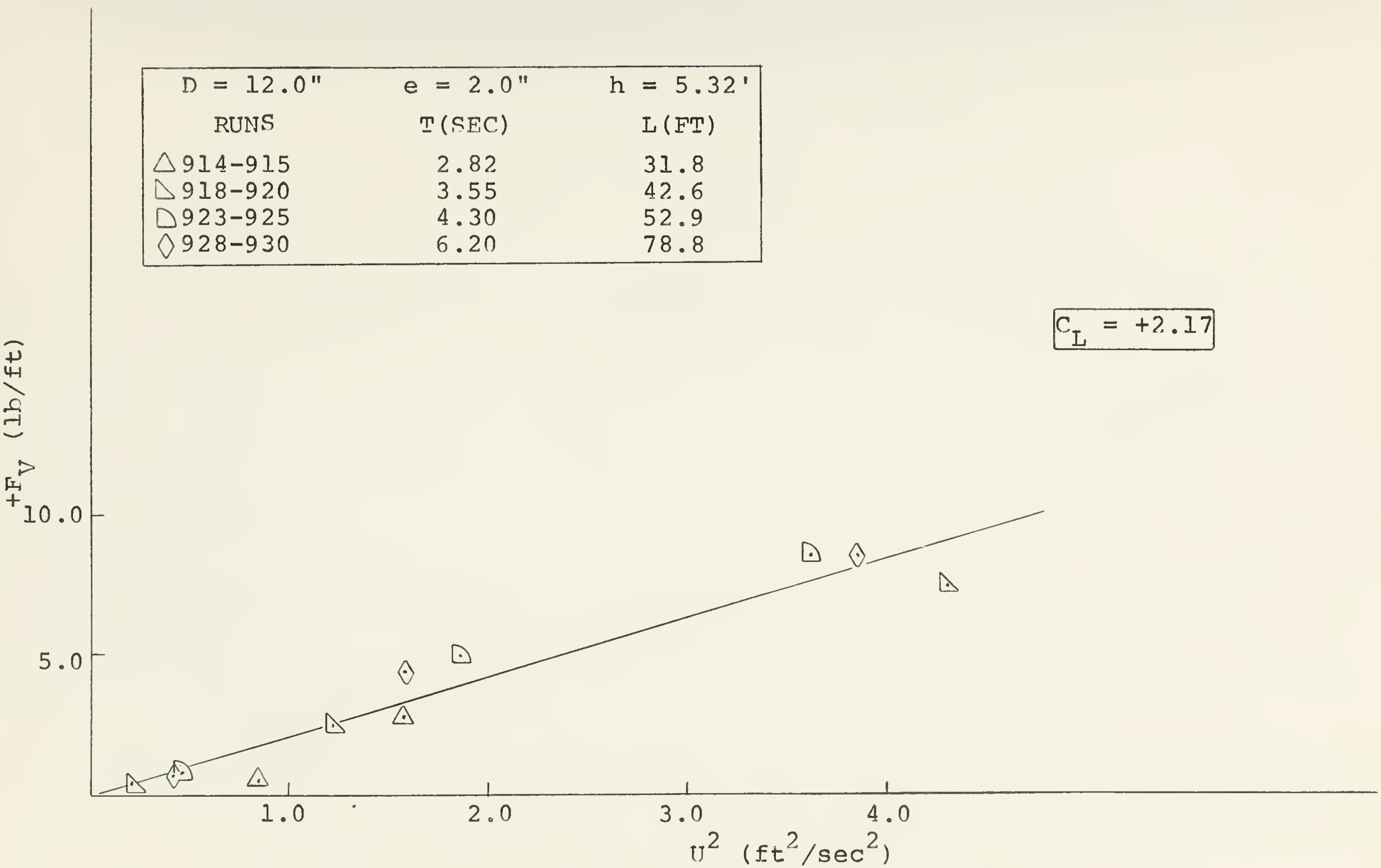

Figure C49. Positive vertical force vs horizontal velocity squared.

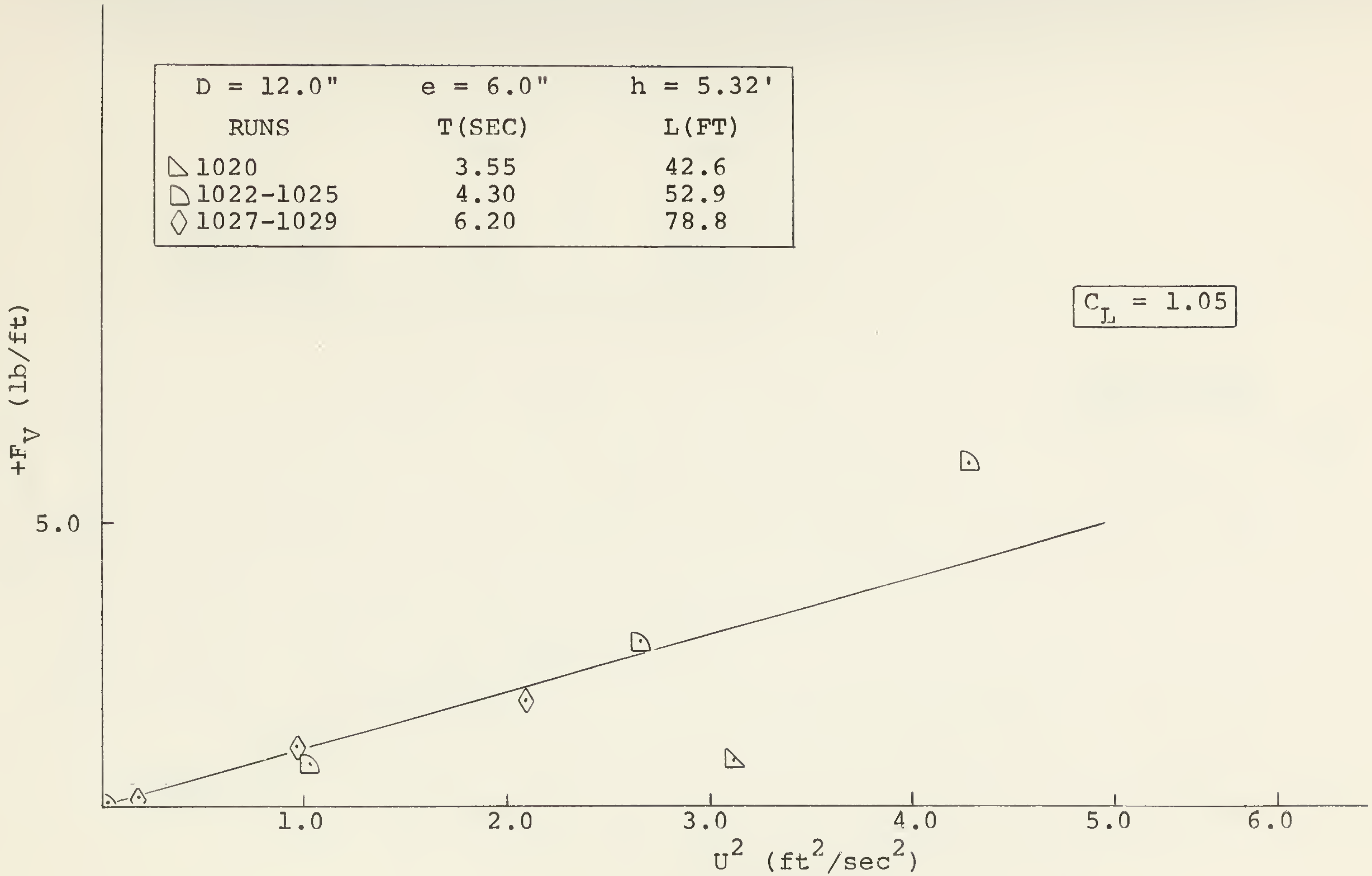

Figure C50. Positive vertical force vs horizontal velocity squared.

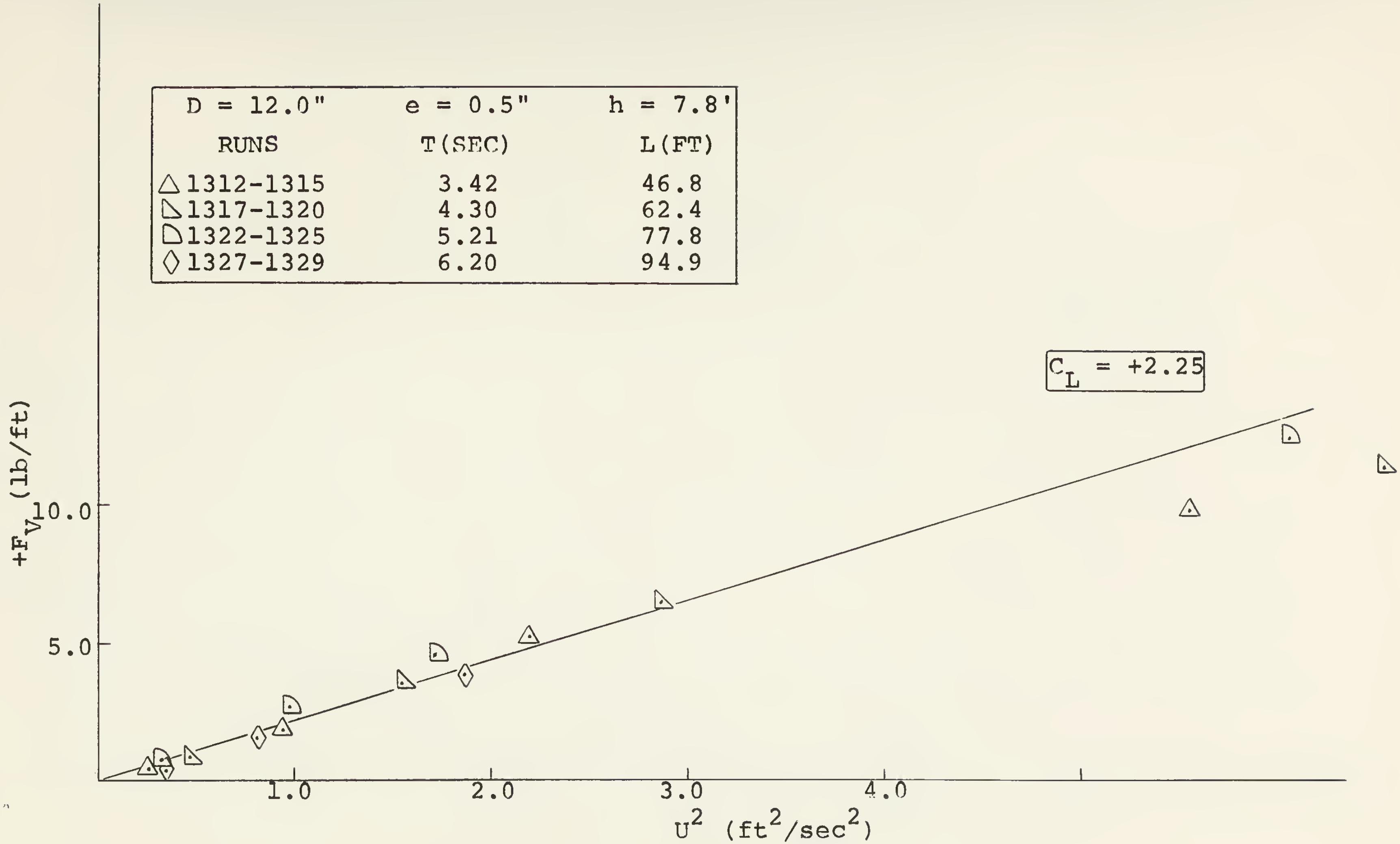

Figure C51. Positive vertical force vs horizontal velocity squared.

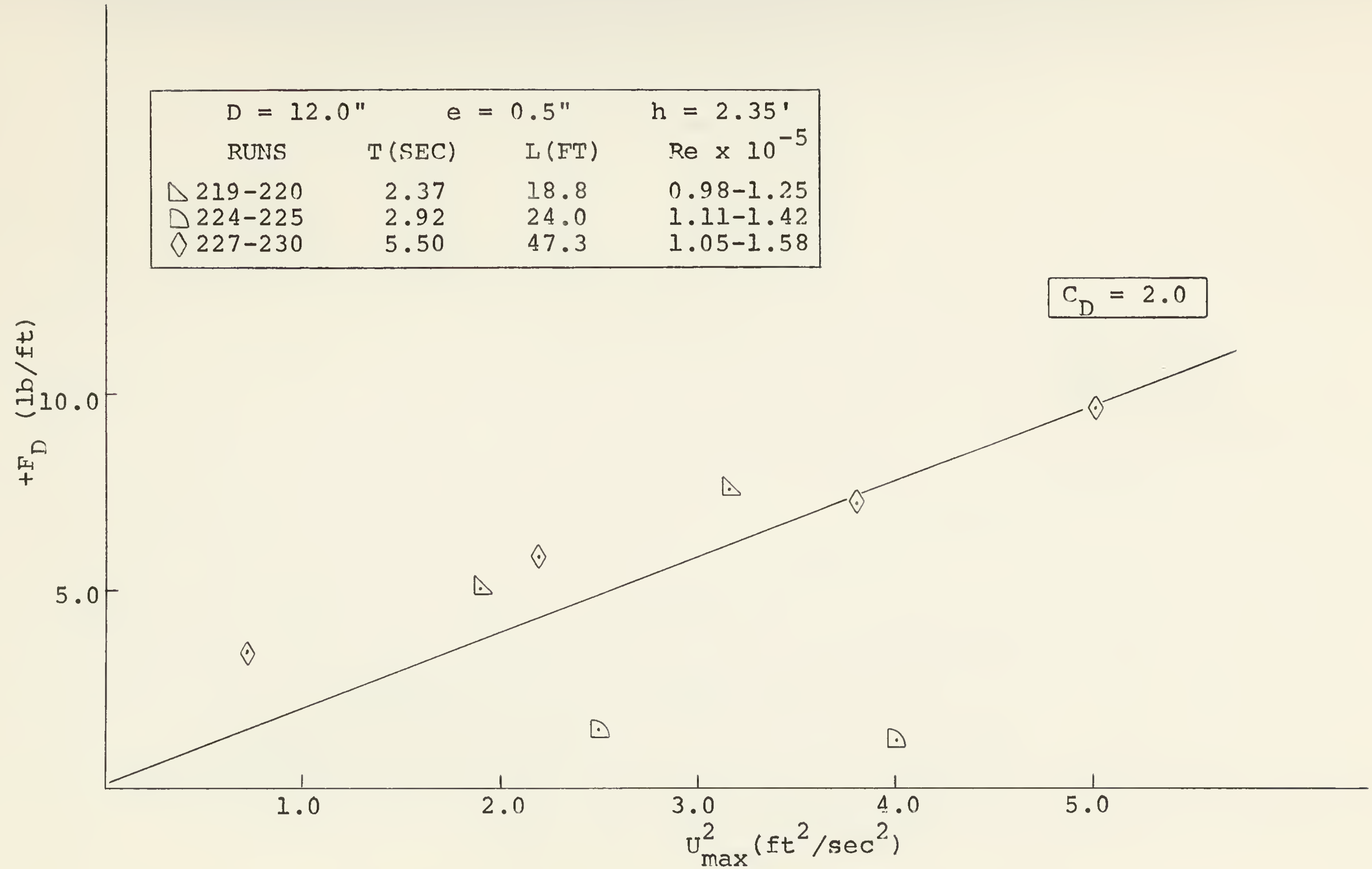

Figure C52. Horizontal drag force vs maximum horizontal velocity squared.

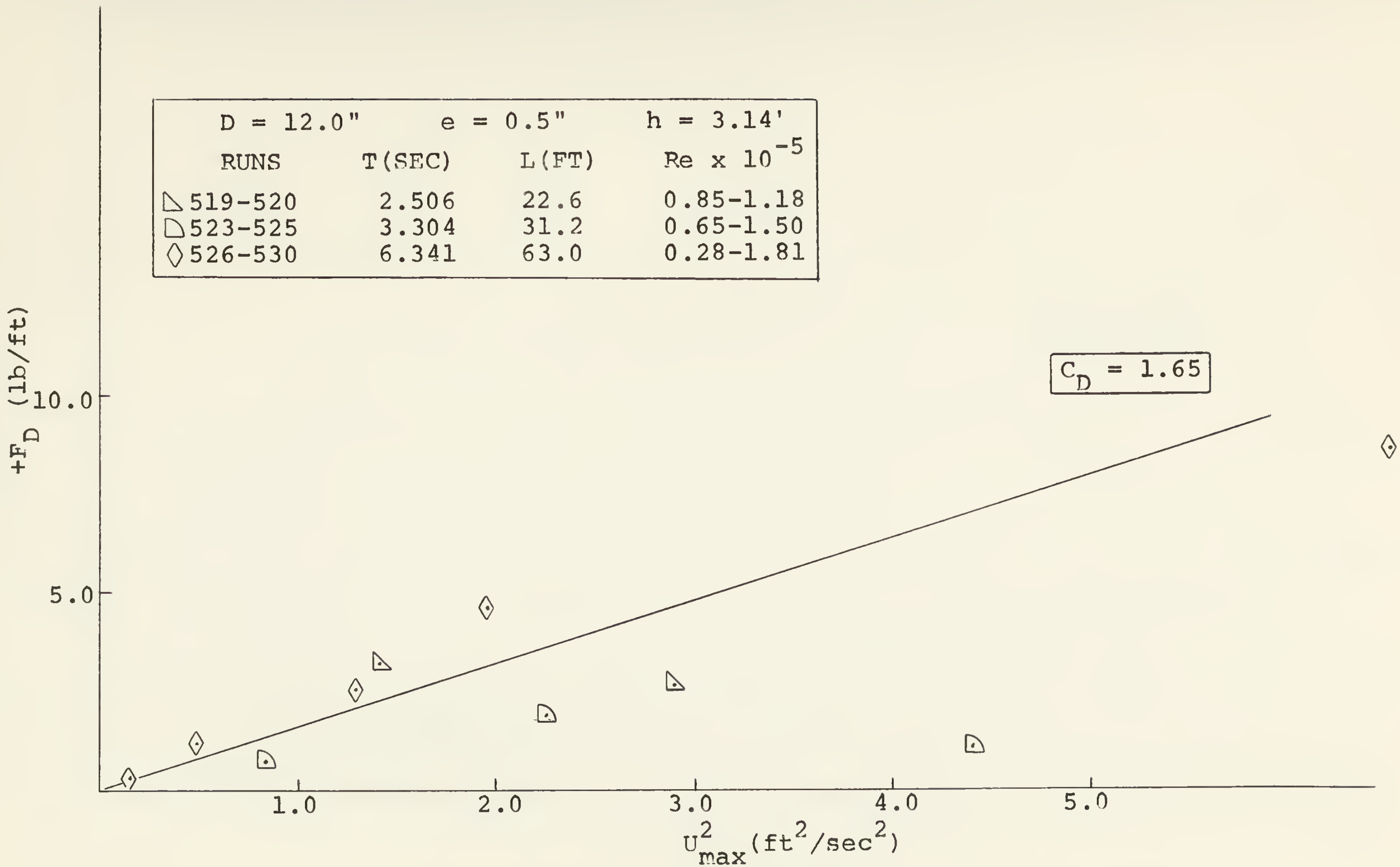

Figure C53. Horizontal drag force vs maximum horizontal velocity squared.

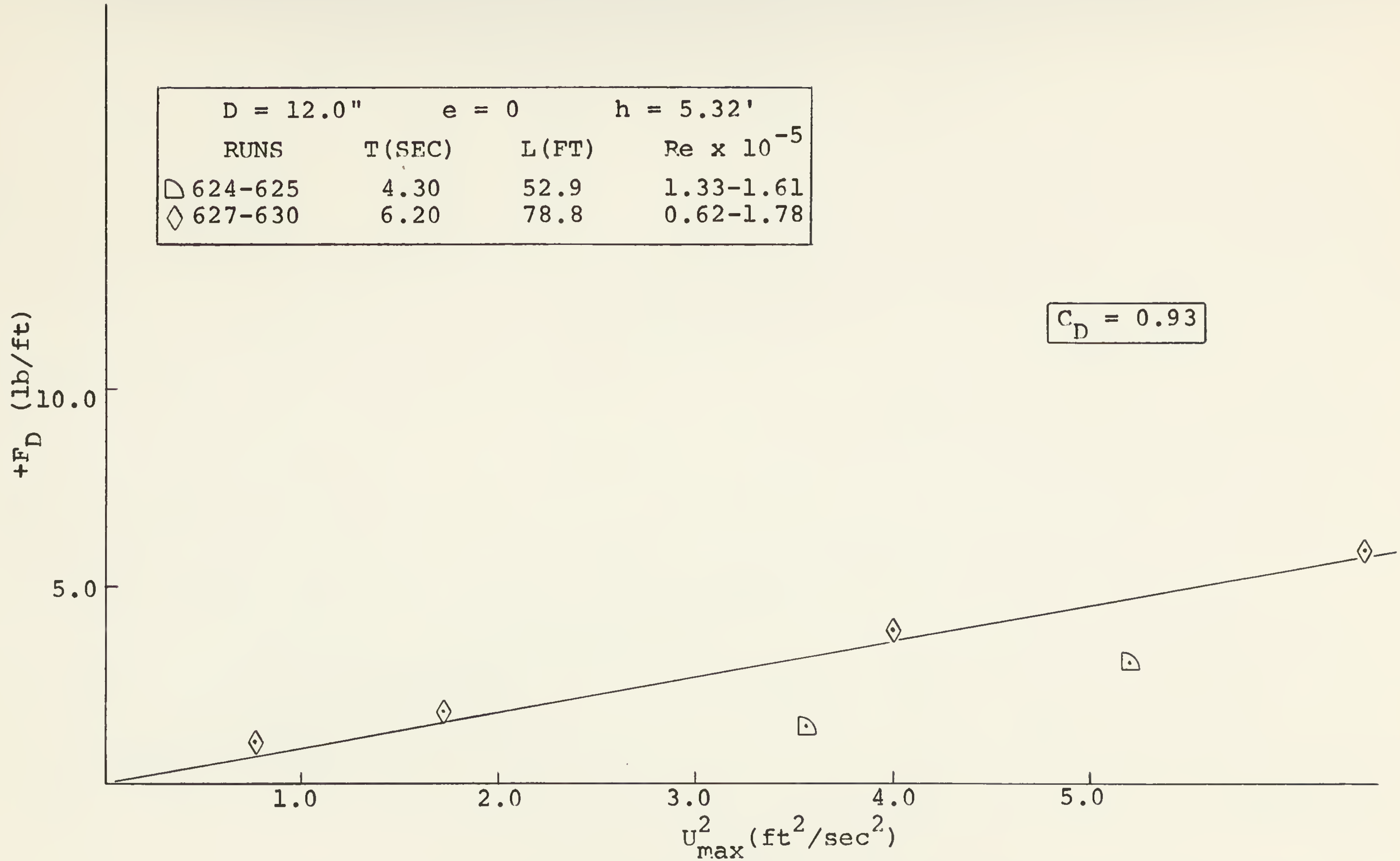

Figure C54. Horizontal drag force vs maximum horizontal velocity squared.

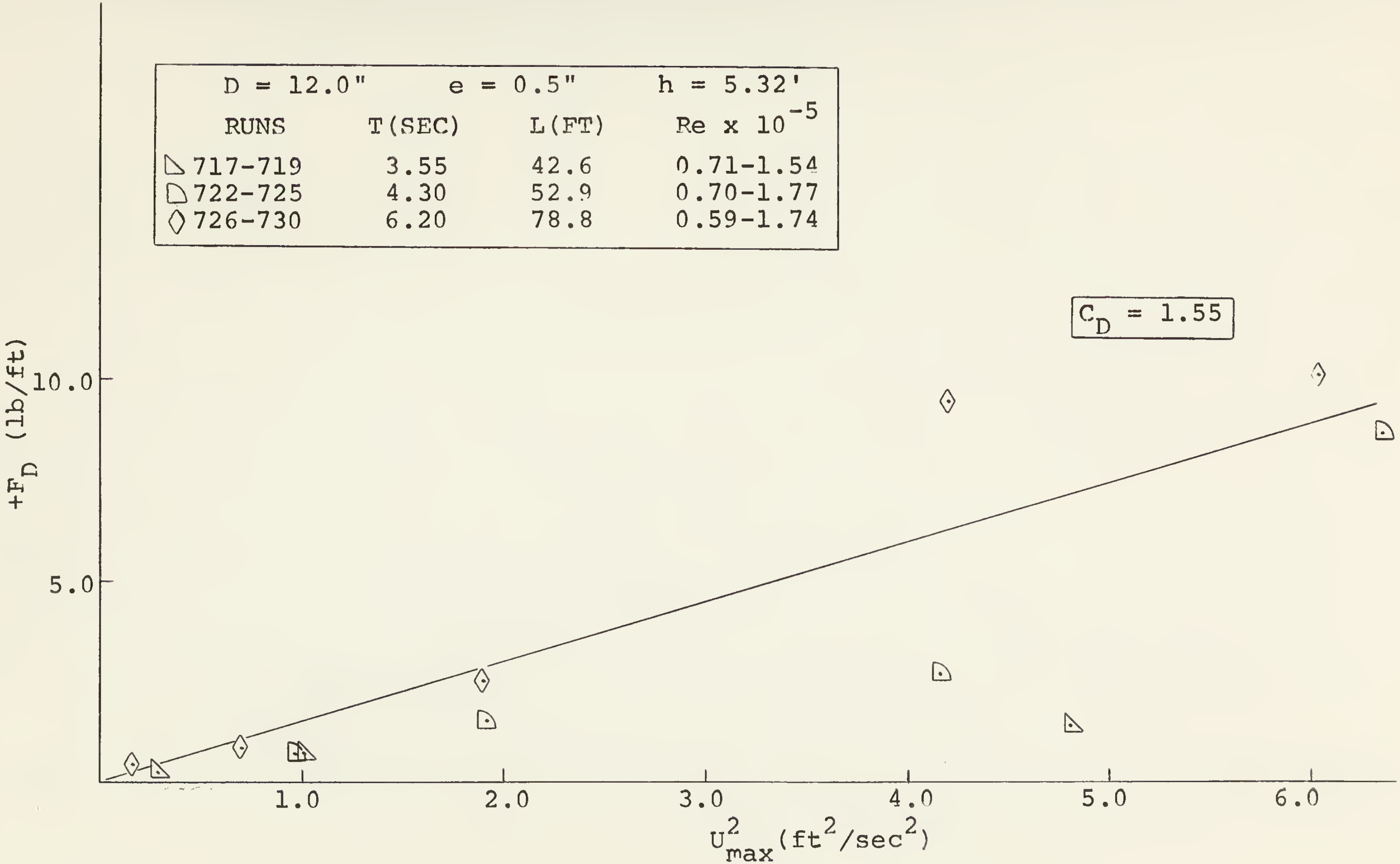

Figure C55. Horizontal drag force vs maximum horizontal velocity squared.

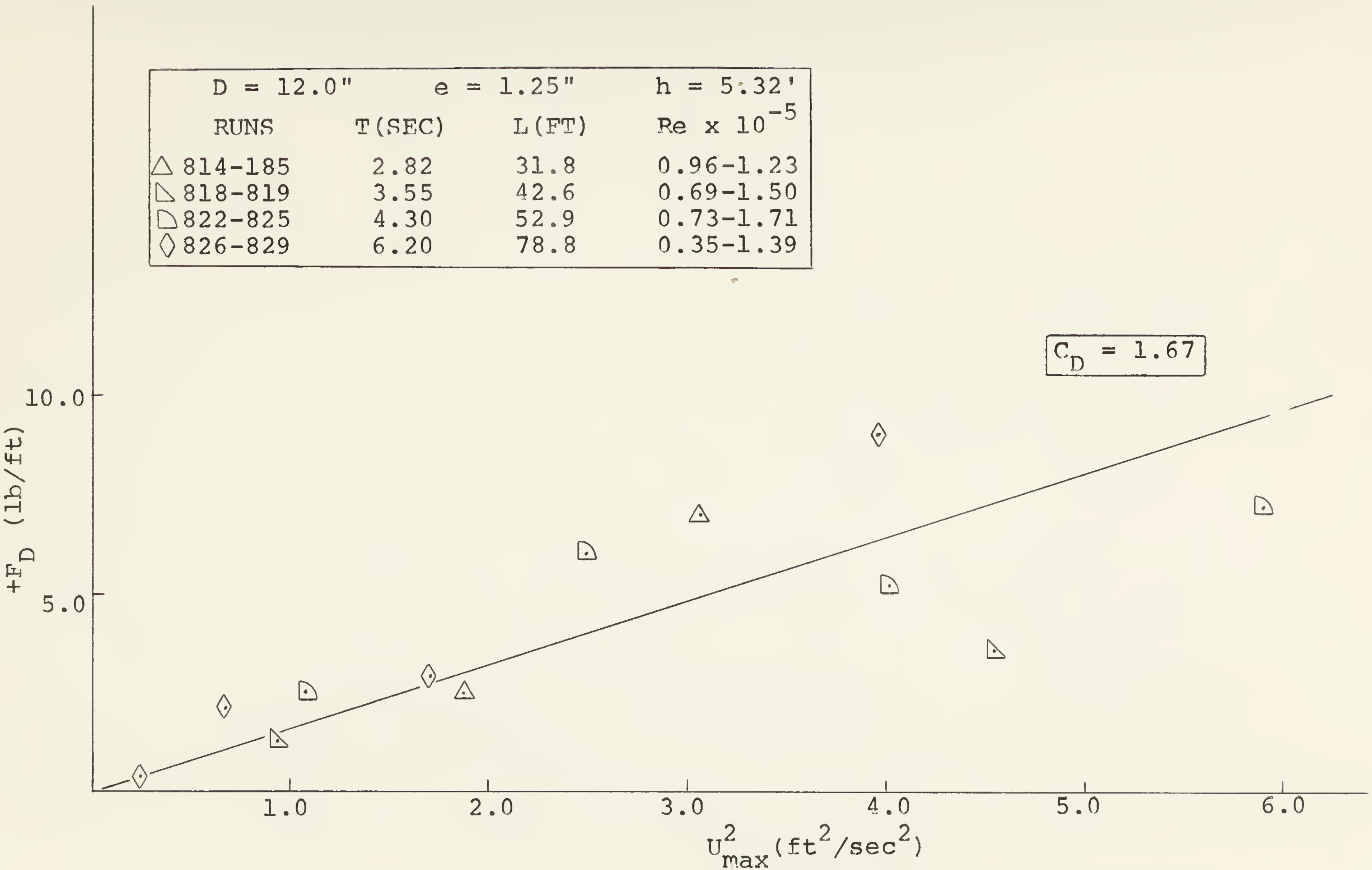

Figure C56. Horizontal drag force vs maximum horizontal velocity squared.

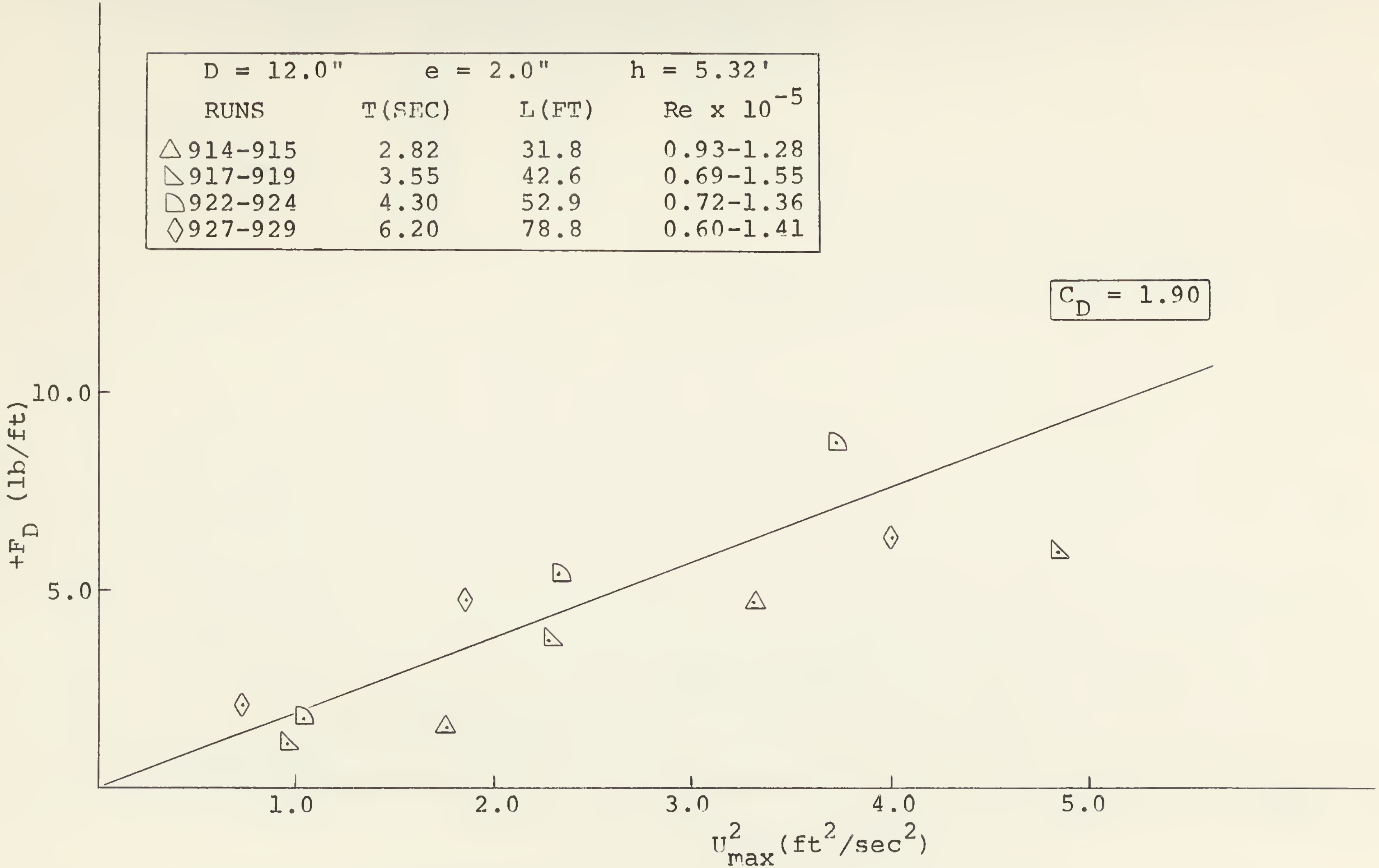

Figure C57. Horizontal drag force vs maximum horizontal velocity squared.

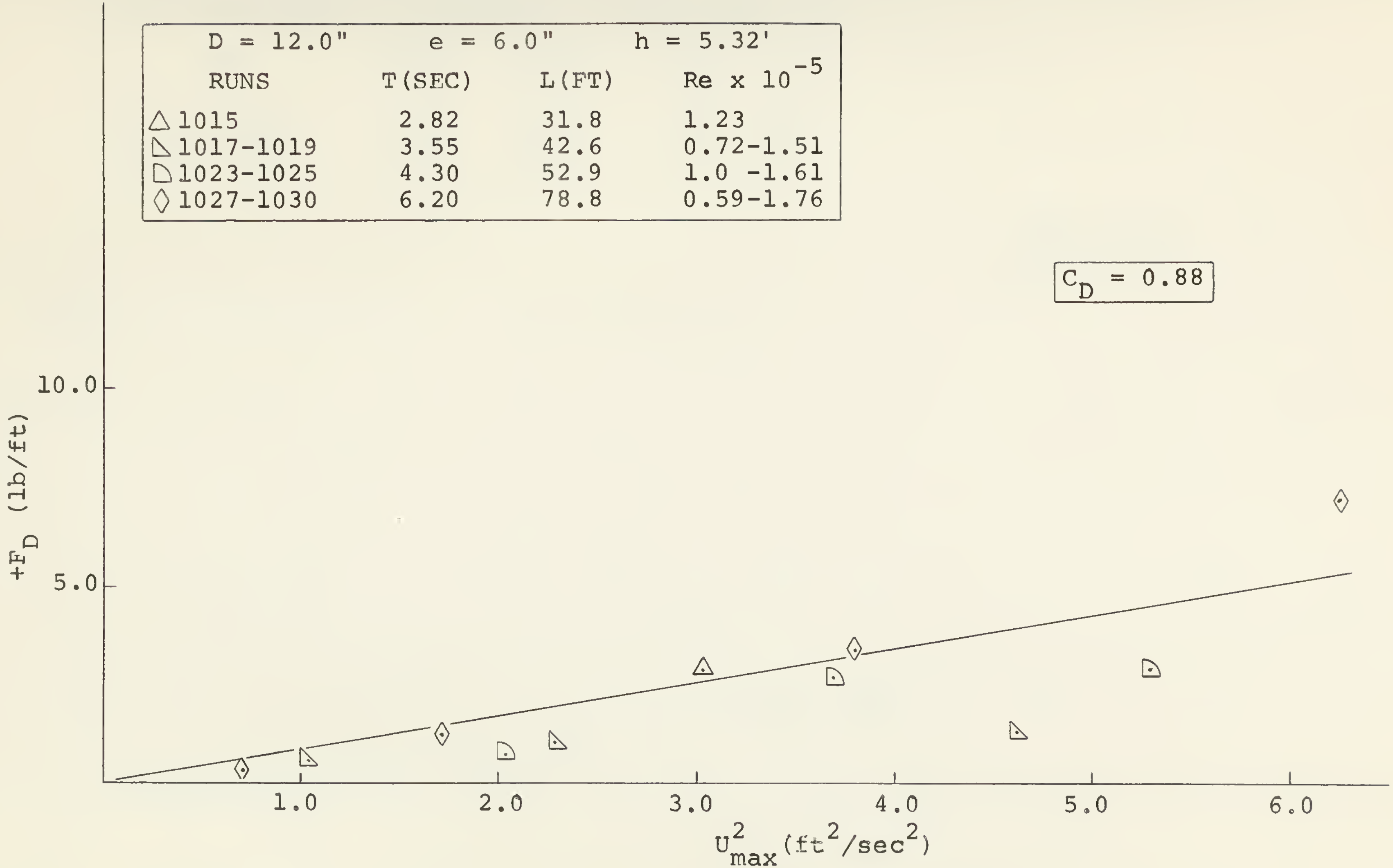

Figure C58. Horizontal drag force vs maximum horizontal velocity squared.

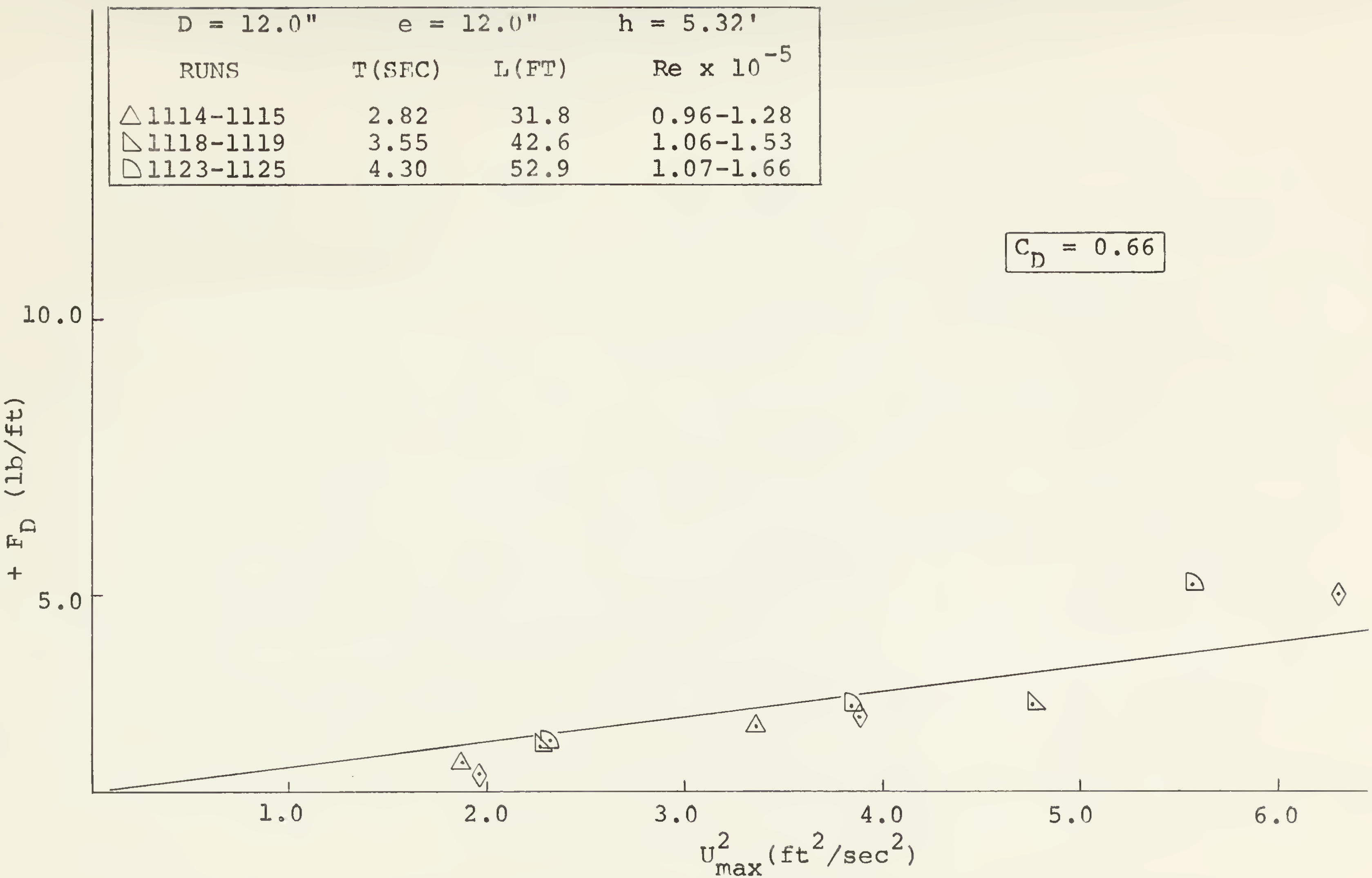

Figure C59. Horizontal drag force vs maximum horizontal velocity squared.

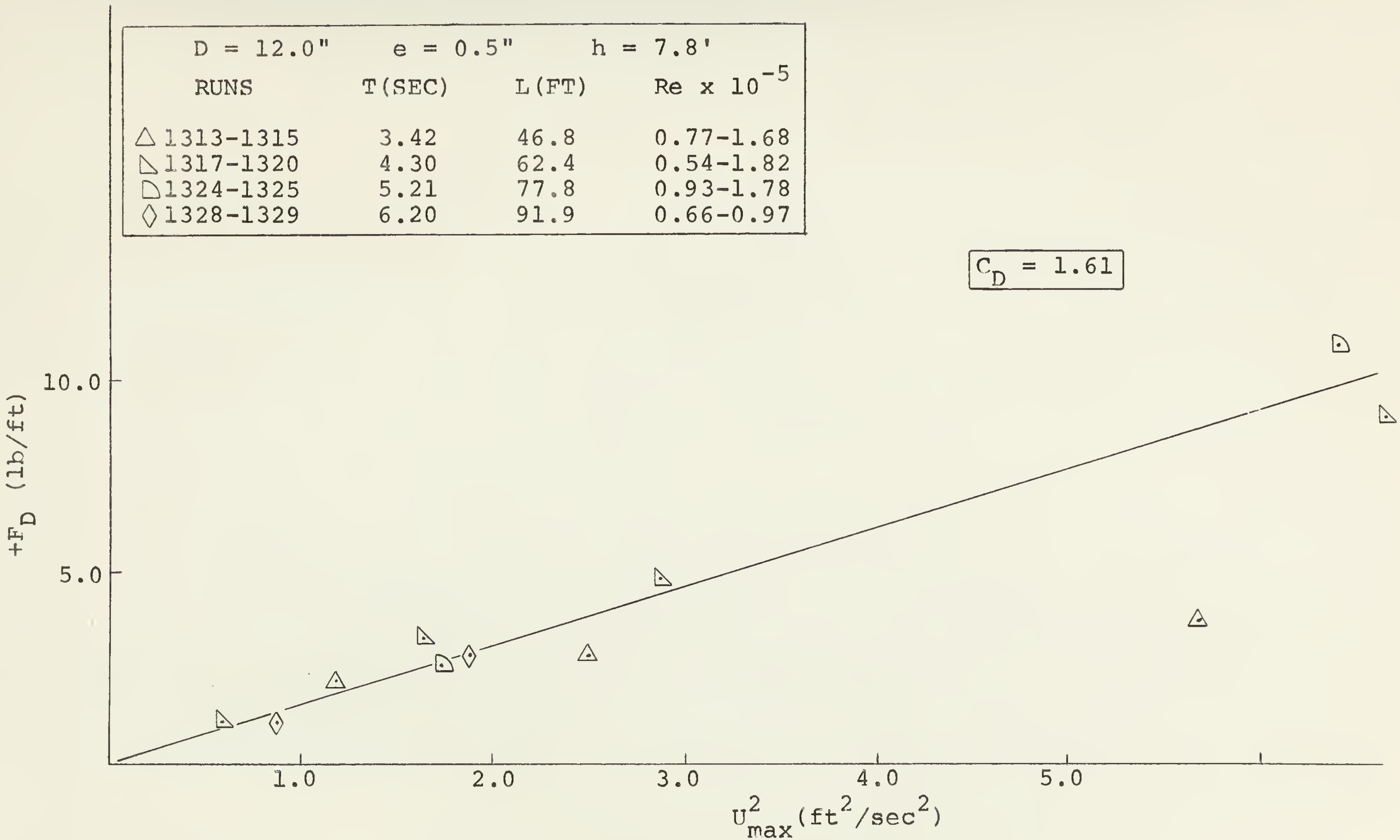

Figure C60. Horizontal drag force vs maximum horizontal velocity squared.